AN EVALUATION OF THE RELATIONSHIP BETWEEN WATER INFRASTRUCTURE FINANCING AND WATER PROVISION IN SOUTH AFRICA

BY

LERATO CAROLINE BAPELA

RESEARCH THESIS

Submitted in fulfilment of the requirements for the degree of

DOCTOR OF ADMINISTRATION IN DEVELOPMENT PLANNING AND MANAGEMENT

in the

FACULTY OF MANAGEMENT AND LAW

(School of Economics and Management)

at the

UNIVERSITY OF LIMPOPO

SOUTH AFRICA

SUPERVISOR: Prof. C.C. Ngwakwe

CO-SUPERVISOR: Prof. M.P. Sebola

2017

DECLARATION

I declare that the thesis titled: *AN EVALUATION OF THE RELATIONSHIP BETWEEN WATER INFRASTRUCTURE FINANCING AND WATER PROVISION IN SOUTH AFRICA*, hereby submitted to the University of Limpopo, for the degree of Doctor of Administration in Development Planning and Management has not previously been submitted by me for a degree at this or any other university; that this is my work in design and in execution, and that all material contained herein has been duly acknowledged.

…… **……**

SIGNATURE **DATE**

(MRS LC BAPELA)

DEDICATION

This research is dedicated to my late grandmother Reshoketshoe Daisy Kubheka. My gratitude goes to my husband Kgampi J. Bapela, my children: Tumisho and Mosa Bapela. I am grateful to my parents, my in-laws, my siblings, the extended family as well as friends. This thesis would not have been possible without your prayers, love and support. Most importantly, I dedicate this work to the Almighty God my Lord and Saviour, Jesus Christ.

ACKNOWLEDGEMENTS

“Now to Him who is able to do far more abundantly than all that we ask or think, according to the power at work within us, to Him be Glory in the church and in Christ Jesus throughout all generations, forever and ever. Amen.” *(Ephesians 3:20-21, ESV)*.

I wish to acknowledge the Almighty God who placed the dream in my heart to pursue this goal. Without His amazing grace I would not have made it this far. My PhD studies would not have been possible without the support and assistance of the following people and institutional information.

My heart felt gratitude goes to Prof. C.C. Ngwakwe and Prof. M.P. Sebola for their motivation, encouragement and guidance throughout the duration of my research period. Their wisdom, experience, insight, motivation and constructive comments have enabled me to complete this thesis report with excellence, for which I am grateful. They presented an ideal team of mentors for whom I’m always grateful to God, without their patience and support I would not have made it this far. Thank you Prof. Ngwakwe for seing the potential in me and for believing enough in me to encourage me to undertake and complete this PhD research. May God richly bless you!

I would also like to express my sincere gratitude to the management of the University of Limpopo for funding my tuition and conference attendance, for affording me the opportunity to further my studies and for allowing me to have the study leave which enabled me to advance and make significant progress towards the completion of my studies. I particularly wish to thank the Department of Water and Sanitation (University of Limpopo) for their support during the period of my study leave.

Thank you to the organisations that provided information that was used for this research and these include: the Department of Water and Sanitation (DWS), Department of Agriculture, Fishery and Forestry (DAFF), Statistics South Africa (StatsSA), Trans-Caledon Tanneling Authority (TCTA), the World Bank and Food and Agricultural Organisation of the United Nations (FAOUN). Thank you to my family and friends for their prayers during the course of my academic studies. They have been my pillars of strength.

ABSTRACT

Whilst previous research has largely blamed inadequate finance as the cause of insufficient water provision and concomitant development implications such as poverty and food production; this thesis, took a slightly different turn and engaged on a critical deconstruction of the relationship between water infrastructure financing and water provision in South Africa.

Archival data on South Africa between 1994 and 2014 were collected on water provision, water-asset finance, governance effectiveness, corruption, violence, accountancy and voice. Data were analysed using the OLS regression fixed effect. Findings from the analysis showed that against popular belief, there was lack of significant relationship between water asset finance and water provision.

However, nonfinancial variables namely corruption, social violence, accountability and voice of citizens in development decisions showed a significant relationship with water provision. In addition, the analysis showed that water provision is significantly related to cereal production and incidence of poverty. Therefore, the thesis emphasized that rural development could be enhanced through an improved effort on water provision, which would increase cereal production and reduce the incidence of poverty. It stressed however, that provision of water asset finance without attention and control of nonfinancial variables might have the tendency to derail water provision initiatives in South Africa.

The thesis made an original contribution by proposing a conceptual framework for employing and researching the catalyst for water provision in South Africa. It also developed three novel research models for future research.

Key words: Infrastructure financing, water infrastructure, water provision, water and development, governance, accountability, poverty reduction

TABLE OF CONTENTS

DECLARATION **ii**

DEDICATION **iii**

ACKNOWLEDGEMENT **iv**

ABSTRACT **v**

CHAPTER 1: GENERAL ORIENTATION OF THE RESEARCH

1.1 Introduction and background 1

1.2 Statement of the problem 2

1.3 Research questions 3

1.4 Research objectives 4

1.5 Significance of the research 4

1.6 Definition of terms 4

1.7 Structure of the Thesis 5

1.8 Validity and reliability 8

1.9 Ethical considerations 8

1.10 Conclusion 8

CHAPTER 2: THEORETICAL FRAMEWORK

2.1 Introduction 9

2.2 Agency Theory 9

2.3 Stewardship Theory 11

2.4 Application of both Agency and Stewardship Theories 13

2.5 Conclusion 14

CHAPTER 3: WATER INFRASTRUCTURE

3.1 Introduction 15
3.2 Aspects of water infrastructure in developing communities 15
3.3 South African water infrastructure 18
3.4 Effects of climate change on water infrastructure 18
3.5 Water provision in developing economies 21
3.6 South African context of water infrastructure financing 23
3.7 Conclusion 24

CHAPTER 4: WATER INFRASTRUCTURE FINANCING AND WATER PROVISION

4.1 Introduction 25
4.2 Financing decisions for water infrastructure development 25
4.3 South African context 27
4.3.1 Fiscal support (National Revenue Fund) 28
4.3.2 Commercial finance through loans and bonds 28
4.3.3 Equity investment 30
4.3.4 *Donor support and green funds* 31
4.4 Water infrastructure financing and water provision 33
4.5 Contrasting view to water infrastructure financing 35
4.6 Economically viable initiatives for water provision 36
4.7 Infrastructure planning for water provision 39
4.8 Cost implication for urbanisation on water infrastructure needs 42
4.9 Conclusion 43

5 CHAPTER 5: GOVERNANCE AND WATER PROVISION

5.1 Introduction 44
5.2 Financial governance and water provision 44
5.3 Water governance and water provision 46

5.3.1 *Urbanisation and water provision* 49
5.3.2 Water usage and management 51
5.3.3 Climate change adaptation planning and water provision 55

5.4 Corruption and water provision 56
5.5 Regulation and water provision 57
5.6 Violence and water provision 58
5.7 Conclusion 59

6 CHAPTER 6: ACCOUNTABILITY AND WATER PROVISION

6.1 Introduction 60
6.2 Accountability 60
6.3 Financial accountability and water provision 62
6.4 Water accountability and water provision 68

6.4.1 Water as a basic human right 68
6.4.2 Obstacles to accountability for water provision 69
6.4.3 Monitoring the integrity of water provision 71
6.4.4 Approaches to Water Accountability 72

6.5 Voice and water provision 74
6.6 Conclusion 75

7 CHAPTER 7: ROLE OF WATER FINANCING ON SUSTAINABLE DEVELOPMENT

7.1 Introduction 76
7.2 The impact of the hydrological cycle and water availability on the economic development 76
7.3 Water infrastructure for socio-economic development 77
7.4 Rainwater harvesting and water infrastructure development 78
7.5 Water conservation as an alternative to infrastructure development 80
7.6 Water quality and water infrastructure management 82

7.7 Effects of water availability on rural women and children 85
7.8 Climate change impact on water availability for subsistence farming 87
7.8.1 Climate change impact on water availability for subsistence farming 87
7.8.2 Water for food production and poverty alleviation 89
7.8.3 *Intervention on water shortage challenges* 97
7.8.3.1 Policy reform for water provision and food production 98
7.8.3.2 Zero-rating of food 99
7.8.3.3 International trade of virtual water 100
7.9 Child mortality due to water pollution 103
7.10 Conclusion 106

***8* CHAPTER 8: RESEARCH DESIGN AND METHODOLOGY**

8.1 Introduction 107
8.2 Research design 107
8.3 Research study area 107
8.4 Target population 109
8.5 Sampling design 109
8.6 Data collection procedure 109
8.7 Type of data collected 110
8.8 Data analysis technique 110
8.9 Probability distribution 114
8.10 Normality test 116
8.11 Heteroskedasticity test 116
8.11.1 White's test 117
8.11.2 Breusch-Pagan test 117
8.12 Conclusion 117

9 CHAPTER 9: DATA ANALYSIS

9.1 Introduction 118

9.2 Analysis of Data on Research Question 1, 2 and 3 118

9.2.1 Regression Results on Test 1–3 for Research Question 1, 2 and 3 119

9.2.2 Interpretation of Results from the test of hypotheses 1, 2 and 3 Research Question 1, 2 and 3 122

9.3 Analysis of Data on Research Question 4 124

9.3.1 *Regression Result on Research Question 4* 124

9.3.2 Interpretation of Results from the test of hypotheses 4a and 4b Research Question 4 129

9.4 Discussion of finding emerging from the statistical analyses of the research questions 1–4 130

9.4.1 Discussion of findings from the statistical analysis in support of research question 1 130

9.4.2 Discussion of findings from the statistical analysis in support of research question 2 134

9.4.3 Discussion of findings from the statistical analysis in support of research question 3 138

9.4.4 Discussion of control variables from the analyses of research questions 1–3 144

9.4.5 Discussion of findings from the statistical analysis in support of research question 4 158

9.5 Conclusion 162

10 CHAPTER 10: CONCLUSION AND RECOMMEDATIONS

10.1 Introduction 163

10.2 Summary of findings 163

10.2.1 Objective 1: To evaluate the relationship between water infrastructure financing and water provision 164

10.2.2 Objective 2: To examine whether there is a relationship between financial governance and water provision 165

10.2.3 Objective 3: To assess the relationship between financial accountability and water provision 166

10.2.4 Objective 4: To examine how water provision relates to rural poverty alleviation 168

10.3 Objective 5: Contribution to knowledge 169

10.3.1 A framework for understanding the catalysts for water provision and corollaries 170

10.3.2 Recommended Application of Framework to Future Research and Water Related Development Policy and Practice 173

10.3.2a Recommended Model for Further Research 173

10.3.2b Recommendations for policy and practice 175

10.4 Limitation of the research 176

10.5 Conclusion 177

REFERENCES 180

LIST OF TABLES

Table 7.1: Area and production of selected cereal crops in South Africa. 96

Table 9.1: OLS Results on Tests 1 – 3: Research Question 1, 2 and 3 and Hypotheses 1 – 3. 120

Table 9.2: Normality Test on Test 1 – 3 120

Table 9.3a: Heteroskedasticity Test on Test 1 – 3. White's test for Heteroskedasticity 121

Table9.3b: Heteroskedasticity Test on Test 1 – 3. Breusch-Pagan test for heteroskedasticity 121

Table 9.4: Test 4 A Results 125

Table 9.5: Normality test on Test 4 A 126

Table 9.6: Heteroskedasticity test on Test 4 A 126

Table 9.7: Test 4 B Results 127

Table 9.8: Normality Test on Test 4 B 128

Table 9.9: Heteroskedasticity on Test 4 B. White's test for heteroskedasticity 128

LIST OF FIGURES

Figure 1.7: The impact of food price Inflation by Income in South Africa, 2007/8 -2008/9 92

Figure 8.1: The Distribution of Mean Annual Rainfall in South Africa 108

Figure 8.2: The Presentation of the p-value analysis 116

Figure 10.1: Tripod Original Contribution of Research 170

Figure 10.2a: Conceptual Framework for Understanding Catalysts for Water Provision and Corollaries 172

Figure 10.2a: Conceptual Framework for Understanding Catalysts for Water Provision and Corollaries (with Directions) 172

LIST OF APPENDIXES

Appendix 1: Water Infrastructure Financing, Water Provision and Governance Variables in South Africa 1994 – 2014 228

Appendix 2: Water Provision and Cereal Production in South Africa 1994 – 2014 229

Appendix 3: Water Provision per Province and Poverty Incidence Per Province 2006 – 2011 230

CHAPTER 1

GENERAL ORIENTATION OF THE RESEARCH

1.1 Introduction and Background

The relentless growth in urbanisation and the persistent development of huge and medium-size urban communities in developing countries have created an increasing demand for an expansion in water infrastructure and water service delivery (Tortajada, 2014). Although the urgency in meeting the growing water infrastructure needs of the society is challenging to both developing and developed countries (Jung et al., 2013), the urgency is more pronounced in developing countries (Reddy, 2015). Whilst effective water service delivery requires improved infrastructure, the infrastructure cannot function in isolation. Infrastructure efficiency and effectiveness rely upon a blend of responsive financing, a proactive governance system and financial accountability (Tortajada, 2014a).

South Africa is a water-stressed country and has suffered from poor water service delivery over a protracted period of time (Chetty & Luiz, 2014), yet water is perceived as a basic human right in South Africa and globally (Mehta, 2014). However, South Africa is experiencing a serious backlog in water infrastructure investment for the management and delivery of water services (Ruiters, 2013). It is therefore not surprising that since 1994, South Africa has constantly faced a number of service delivery challenges relating to water (Nleya, 2011).

At the inception of democracy in 1994, South Africa had a population size of 40 million people. Of those, 15, 2 million people (12 million of whom lived in rural areas) lacked access to a basic water supply (Muller & Lane, 2002). To date, there is still a pervasive insufficient provision of safe drinking water in many parts of the country (Mackintosh & Colvin, 2003; Kehler, 2013). Water infrastructure financing has been blamed for the lack of the effective distribution of water to all the citizens (Bakker, 2013). The majority of capital investments in South Africa were made in the 1970s and 1980s and only catered for a small population. The increased population size in urban areas means that the existing water infrastructure is not sufficient to carry increasing demands for water services (Hanjra & Qureshi, 2010).

According to Ruiters (2013), the under-investment in the South African water infrastructure was estimated at more than R600 billion per annum in 2011. Hence there is a dire need to find a solution to this backlog by putting in place new institutional structures and a water infrastructure financing framework to enhance water infrastructure and water provision. Although the preceding speculative allusions exist about low water infrastructure investment in South Africa, empirical research that points uniquely to the relationship between water infrastructure financing and water provision in South Africa has not yet been carried out. This research thus provided an examination of how water infrastructure financing related to water provision in the country and it proceeded to suggest a framework to improve water infrastructure financing and governance to enhance water service delivery and sustainable development in South Africa.

1.2 Statement of the problem

South Africa is experiencing a serious backlog in water infrastructure investment for the management and delivery of water services (Ruiters, 2013). However, this problem is not unique to South Africa. Research indicates that water infrastructure financing is a major problem inhibiting effective water provision in many developing economies (Sanders et al., 2013). There is, therefore, a dire need to improve water infrastructure finance and governance in South Africa. Although finance is important for water provision, financial provisioning without effective financial governance may still present a problem in securing the expected water service delivery (Mehta & Knapp, 2004). Efficient financial governance is crucial for attracting and retaining water infrastructure financing (Gonzales De Asís et al., 2009). Current research has found that, despite sufficient water infrastructure financing, lack of financial governance and financial accountability in the water sector may present an obstacle to public water delivery (Egan, 2014).

Although water infrastructure and water service provision are in dire need of expansion in South Africa (Ruiters, 2013), recent research about water delivery in South Africa has not focussed much attention on the financing aspect of water infrastructure. Rather, the attention of research has related to issues such as water foot-printing in the mining industry (Ranchod et al., 2015), extractive based infrastructure in South Africa with cursory highlighting on financing as a problem (Bond, 2014), the effect of large and small dams on agricultural productivity in South Africa (Blanc & Strobl,

2014), and rescaling South Africa's water resource management (Bourblanc & Blanchon, 2014). The closest related researchers are Mostert and Van Heerden (2015) on general infrastructure expenditure in Limpopo province and Ruiters (2013) on a water infrastructure-funding model. Mostert and Van Heerden's (2015) research dwelt on "*Computable General Equilibrium (CGE) Analysis of the Expenditure on Infrastructure in the Limpopo Economy in South Africa"* (Mostert & van Heerden 2015: 227), but only touched briefly on water infrastructure expenditure, amongst other infrastructures. It also had an exclusive focus on the Limpopo Province alone. Additionally, it did not seek for a relationship between water infrastructure financing and water provision in South Africa. Instead, the research by Ruiters (2013) focussed simply on suggestions for a water infrastructure funding model for South Africa. It also did not examine the relationship between water infrastructure financing and water provision in South Africa. Therefore, the previous research in South Africa differs from the author's intended research focus because none of these investigations sought a relationship between water infrastructure financing, governance and accountability of water provision in South Africa. Hence, to the best of the author's knowledge, after a rigorous literature search, published research in South Africa that focussed uniquely on the author's current research focus in South Africa is uncommon. This research bridged a gap in the literature and therefore made a contribution that is unique to water infrastructure and financing by relating water infrastructure financing, governance, and accountability to water provision in the country. Furthermore, this research suggested an improved framework for water infrastructure financing, governance and accountability for sustainable water service delivery and development in South Africa.

1.3 Research questions

This research addressed the following questions:

i. How does water infrastructure financing relate to water provision?

ii. What kind of relationship exists between financial governance and water provision?

iii. How does financial accountability relate to water provision?

iv. How does water provision relate to rural poverty alleviation?

v. What possible framework may enhance an understanding of catalysts for water provision and corollaries?

The main aim of the research was to establish the impact the water infrastructure financing has on water provision in South Africa.

1.4 Research objectives

In order to respond to the research questions, the research objectives were:

i. To evaluate the relationship between water infrastructure financing and water provision.

ii. To examine whether there is a relationship between financial governance and water provision.

iii. To assess the relationship between financial accountability and water provision.

iv. To examine how water provision relates to rural poverty alleviation.

v. To propose a framework for understanding catalysts for water provision and corollaries.

1.5 Significance of the research

Given the current problems of water provision in the country and the absence of research on the relationship between water infrastructure financing, governance and accountability, this research was significant as it contributed a framework that may guide policy makers to improve water infrastructure financing, accountability and the provision of water. It further contributed to literature by bridging the current gap in research about this research focus.

1.6 Definition of terms

Water Infrastructure is water-related infrastructure which includes dams, bore-holes, reticulation pipes, bulk storage tanks (water reservoirs) which are used to supply water to consumers (Briscoe, 1999).

Integrated Water Resource Management (IWRM) is a process that promotes coordinated development, management and governance of water resources in order

to maximise socio-economic welfare in an equitable and sustainable manner (Global Water Partnership, 2000).

Water Governance is the range of economic, social, political and administrative systems established to develop, manage and deliver water resources at various levels of society (Rogers & Hall, 2003).

Water Accountability is the obligation of an individual or organisation to account for water related activities, accept responsibility for them, and to disclose the results in a transparent manner. It also includes the responsibility for money or other entrusted property (Egan, 2014).

Sustainable Development is the development characterised by low economic growth rate, absence of pollution, and greatly diminished environmental impact. It is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Griggs et al., 2013).

Community engagement involves efficient communication between water service providers and community members, as well as participatory budgeting of municipal finances by community members, leading to financial accountability and transparency within the local government (Gonzales de Asis et al., 2009).

Water Conservation refers to any beneficial reduction of water usage, loss or waste. It also includes the strategies and activities to manage and protect water resources to meet the demand for human consumption (Organisation for Economic Cooperation and Development, 1997)**.**

Corporate governance refers to the structures, processes and actors and the dynamic interactions among them that facilitate and influence decisions affecting a corporation (Kihara, 2016).

1.7 Structure of the Thesis

The final dissertation report consists of ten major chapters which are outlined as follow:

Chapter 1: This chapter introduced the background and the context of the research. It also detailed the problem statement which was investigated in the research which was subsequently followed by the research questions, objectives, significance of the

research, definition of terms, structure of the thesis, validity and reliability, ethical consideration, limitation and delineation.

Chapter 2: A theoretical framework that underpins this research work was presented in this chapter. Both Agency and Stewardship theories were introduced while referring to previous researches wherein they were applied in the public utility service research in other countries. Both theories were then applied in the context of this research.

Chapter 3: A literature review was covered in this chapter which includes a scientific review of literature concerning the aspects of water infrastructure financing in developing economies, water infrastructure in South African context and the effect of climate change on water infrastructure.

Chapter 4: This chapter presented a literature review on water infrastructure financing and water provision. The literature covered the financial decision for water infrastructure development in general in the South Africa context. The South African context which entails fiscal finance, commercial finance, equity investment, donor support and green funding was presented. Furthermore, literature on water provision as a result of water infrastructure financing and other factors were also presented. Economical water supply, infrastructure planning, the cost of urbanisation on water infrastructure were also covered in this chapter.

Chapter 5: The literature review of governance on water provision was presented in this chapter. This chapter reviewed the literature on the impact of financial governance, water governance, urbanisation, water usage and management, climate change and adaptation planning on water provision. Furthermore, the impact of corruption, regulation and violence on water provision was also addressed in this chapter.

Chapter 6: This chapter presented the literature about accountability in terms of financial accountability and citizen voice and their impact on effective water provision. The concept of accountability and financial accountability for water provision was addressed in this chapter. In addition, literature on the impact of citizen voice on water provision; as well as the obstacle to accountability for water provision; monitoring the integrity of water provision; and water accountability approaches are also presented in this chapter.

Chapter 7: Literature on the role of water infrastructure on Sustainable Development was presented in this chapter. This chapter included the impact of the hydrological cycle and water availability on socio-economic development. It also coverd rainwater harvesting and water conservation measures and water infrastructure development; poor water quality and water provision; water availability for rural women and children; climate change impact on water for subsistence farming and child mortality resulting from water pollution.

Chapter 8: This chapter presented the research design and methodology. In this chapter, research design, the research area, target population, sampling design, data collection and data analyses were discussed. The research had no ethical implication since it employed secondary data which was available on a public domain. As a result there was no use for requesting permission from the respective organisations, there was no need for a concent form to be submitted to the target organization since there were no taget participants involved and confidentiality was not a concern. The research methodology also introduced the regression model, probability distribution and normality test which were used to analyse data for this research.

Chapter 9: Data analysis was addressed in this chapter which presented the results obtained from the statistical data analysis and interpretation for South Africa for a period of 1994 to 2014. It sought to address all the research questions with the support of existing literature. In response to research questions 1, 2 and 3, a multiple regression analysis was used where water provision was used as an independent variable, while other variables including water asset financing, governance, and accountability, were used as dependent variables and corruption, voice, violence, and regulation, as control variables. Similarly, research question 4 which addresses water provision as an independent variable was tested on a probability distribution against cereal production. All the research questions were subjected to a Normality Test, White's Heteroskedasticity Test and Breusch-Pagan Heteroskedasticity Test for heteroskedasticity in order to determine the error of variance.

Chapter 10: This is a concluding chapter that presents a summary of findings from the statistical analyses of this research and indicated how these findings have met the objectives of this research. This chapter also presented the contribution of the research to the body of academic knowledge through, firstly, answering the 4th

research question and objective by proposing a framework for enhancing water infrastructure financing and water provision; secondly, by making use of the framework, further research recommendations (with a suggested model) have been provided as a starting point of further research, and thirdly, the researcher proposed on how to improve water provision to members of the public in rural South Africa.

1.8 Validity and reliability

The use of multiple sources of data was used in order to enhance the reliability and validity of the data (Mouton, 1996). In this research, reliability was enhanced by using secondary data from credible sources of information derived from DWA, DAFF, StatsSA, TCTA, FAOUN and the World Bank that have been professionally examined and made available to the public domain. Furthermore, the researcher also conducted a collinearity test to determine the independence of the variables under research (Becker et al., 2015).

1.9 Ethical considerations

Research ethics are moral principles that govern a researcher's behaviour while conducting research (Myers & Venable, 2014). This research employed reliable secondary archival data which are not manipulated, therefore ethical issues in data collection related to proper attribution of data. All sources of data collected was duly acknowledged by the researcher in accordance with the rules of academic research and the University of Limpopo.

1.10 Conclusion

This chapter presented an introduction and background of the research. It covered the problem statement, research questions, objectives, significance of the research, definition of terms, structure of the thesis, validity and reliability, ethical considerations, limitation and delineation, which pave the way for the rest of the document. The next chapter presents theoretical frameworks that underpins the work covered in this research.

CHAPTER 2

THEORETICAL FRAMEWORK

2.1 Introduction

This chapter presents a theoretical framework that underpins the work covered in this research. Both Agency and Stewardship theories are introduced while referring to previous researches wherein they were applied in the public utility service research in other countries. Both theories were then applied in the context of this research.

2.2 Agency Theory

The Agency theory, also frequently referred to as the principal-agent model, is used in the organisational economics and management literature as a theoretical framework for structuring and managing contract relationships and to explain the behaviour of principal and agent (Hiller & Verdier, 2014; Luo & Chung, 2013; Atkinson & Fulton, 2015). The agency theory analyses the effects of contractual behaviour between two parties: principal(s) and agent(s). This relation is inevitably characterised by information asymmetry because the agent holds a substantially larger volume of information than the principal (Luo & Chung, 2013; Atkinson & Fulton, 2013). The Agency theory is a concept that is used in various fields including accounting, finance, marketing, political science and sociology. This theory focuses on accountability by correcting opportunistic behaviour that may result from exploiting asymmetric information (Van Slyke, 2007). The principal-agent model has been extensively applied to contractual relations between organisations, boards and directors, and managers and employees in for-profit, public, and non-profit organisations (Schillemans & Busuioc, 2015; Raelin & Bondy, 2013). Due to the inherent risk of information irregularities for the principal, supplementary costs associated with monitoring agents need to be covered by the principal (Van Slyke, 2007; Attila, 2012; and Raelin & Bondy, 2013).

A number of scholars have applied the concept of the Agency Theory in various fields. Notably, the public utility sector where government and public servants are viewed as agents who render services to members of the public who are the principals. For example, Attila (2012) conducted a research on ‘Agency Problems in the Public

Sector'. In this research, he looked at the application of the agency theory between the principal (who is the government) and the agency (who is a service provider). Their relationship is formalised through a contractual agreement. According to Attila (2012:708), one of the challenges encountered in this agency relationship is the fact that most of the information resides in the hands of the agent and that the principal is often deprived of access to that information. Often this problem occurs when there is no monitoring of all the key milestones by the principal.

Similarly, Box (1999) and Schneider et al., (2011) agree that the public sector continues to encounter increasing demands to run government like a business, importing private sector concepts such as entrepreneurism, privatisation, treating the citizen like a "customer," and management techniques derived from the production process. In his research, Box (1999) observed that the new public management approach seeks to emphasise efficient, instrumental implementation of policies, removing substantive policy questions from the administrative realm. This revival of the politics-administration dichotomy threatens core public-sector values of citizen self-governance and the administrator as servant of the public interest. Likewise, researches undertaken by Onukwuli (2014) and Raelin and Bondy (2013) looked at corporate governance practices and regulatory agencies on the performance of government establishments in developing countries. Their researches reveal that corporate governance has a positive and significant relationship with the performance of corporate governance regulatory agencies.

Thus, in the context of the public sector, a public department as an agent has to have a governance with inbuilt accountability. This is why, the research conducted by Box (1999), Onukwuli (2014) and Schillemans & Busuioc (2015), highlighted that public regulatory agencies can deliver effective services in an atmosphere of transparent governance in which accountability is key. In South Africa, for instance, the application of the agency theory has been prevalent in the public sector, where a relationship between government and citizens is established. In a public sector, members of the public (citizens who are taxpayers), entrust government employees with the responsibility of providing services to the public. In the case of water provision, a measure of accountability is expected by citizens from the government. These expectations include adequate provision of water, management of water assets and effective governance of water and accountability. Since public servants are agents, by

implication they are stewards of the people. Hence this work is anchored not only on the Agency Theory, but also on the Stewardship Theory (Van Puyvelde et al., 2012; Gilliland & Kim, 2014).

The Agency theory, therefore, seeks to understand the challenges created when one party, the *agent*, is acting for another, the principal (Mitnick, 2015). Therefore, it has two sides: the activities and problems of identifying and providing services of "acting for" (agent side), and the activities and problems of guiding and correcting agent actions (the principal side) (Mitnick, 2015). Since there are costs associated with all actions and corrections, it often does not pay the principal (or the agent) to insist on, or provide, perfect agency. Nonetheless, social institutions must routinely manage such imperfect conditions. Given such challenges, the fiduciary norm helps solve the institutional dilemmas of ensuring trustworthy behaviour and to ensure that the agent performs as perfectly as possible for the principal. Thus, Mitnick's research presents the basic arguments of the agency theory, its origins, and the varieties of work being done. Consequently, his research determined that the best-known application of the theory of agency applied the economic theory of agency to the theory of the firm, though the agency theory, including the more general institutional theory of agency, has applications throughout social science. The institutional theory of agency is not constrained by assumptions embedded in economic theory or to the modelling of the corporation alone (Mitnick, 2015).

2.3 Stewardship Theory

The Stewardship Theory examines relationships and behaviour often discounted in organisational economic theories, emphasising collective, pro-organisational, contractual behaviour in which a higher value is placed on goal convergence than on agent self-interest (Van Slyke, 2007; Van Puyvelde et al., 2012; and Gilliland & Kim, 2014). In addition, the Stewardship Theory exists where managers are not motivated by individual goals, but rather are stewards whose motives are aligned with the objectives of their principals. The assumptions of the Stewardship Theory are that long-term contractual relations are developed based on trust, reputation, collective goals and involvement where alignment is an outcome that results from relational reciprocity. In addition, a stewardship-based approach assumes that non-profit organisations are motivated to act in the interests of their donors (Biesenthal & Wilden,

2014; Van Slyke, 2007; and Van Puyvelde et al., 2012). Therefore, in the context of the public sector, the application of a Stewardship Theory suggests that the Department of Water and Sanitation serves as a steward to members of the public. Members of the public, who are principals and taxpayers, expect the government as stewards to deliver optimum and efficient services such as sustainable water provision to citizens.

There is growing consensus among researchers that the worsening global water stress and associated physical, regulatory and reputational water risks require a stewardship approach involving collective action and community engagement among public and private sectors, NGOs, and communities (Richards, 2016). Consequently, Corporate Water Stewardship (CWS) proves to be a strategic approach for global corporates to mitigate water risks thus publicly disclosing their water risk and responses to initiatives such as the Carbon Disclosure Project's Investor Water Program (Richards, 2016). In his research, Richards (2016) examined full public responses of 327 global corporations (the Full Disclosers) to the 2014 CDP-IWP survey, with the aim of understanding the most important factors related to CWS. It was hypothesised that physical, regulatory and reputational water risks would explain a significant variance in CWS practices amongst the research participants. Richards' (2016) findings provide insights into CWS practices among global corporations that fully disclosed to the CDP- IWP. These findings can be used to inform policy-makers on how to engage corporations in collaborative and collective actions for sustainable water resources management and governance.

Similarly, Vinnari and Näsi (2013) undertook a research on the financial and technical competence of municipal board members, an empirical evidence from the water sector. The aim of their research was to investigate municipal board members' financial and technical competence and analyse factors explaining the presence of such competence. Their approach involved the estimation of the financial expertise which was constructed based on the board members' education and professional experience, while financial literacy levels were estimated based on prior board experience and participation in additional training in accounting and finance. Furthermore, Board members' technical competence was assessed in terms of their education. Quantitative data were derived from a survey administered to 354 municipal water utility board members in Finland. The response rate was 52%. Vinnari and

Näsi's research results indicate that, first, that municipal board members' estimated financial competence levels are not high and that financial competence is associated with organisational form. Secondly, board members' technical competence levels are also fairly low and technical competence is associated with political affiliation. Thus, in the context of their research, a Stewardship theory offered the most acceptable explanation for the influence of organisational form on financial and technical competence, while the resource dependency view provides an explanation for the effect of political affiliation on technical competence (Vinnari and Näsi, 2013).

Equally, Schillemans (2013) examined the relationships between central government departments and agencies through the stewardship theory. Stewardship theory has been developed as an alternative to agency theory and focuses on shared goals and norms. His research showed how current regulations are strongly imbedded in the agency theory. In addition, the analysis of how the problems experienced by public managers generally point to the relevance of stewardship was also conducted through a survey and focus groups. It was on this basis and with input from sixty public managers that a stewardship model was developed for the relationships between agencies and central governments.

2.4 Application of Agency and Stewardship Theories

Although previous research applied both Agency and Stewardship in different contexts, some scholars have researched on the application of both researches. For example, Mills (2014) undertook a research in which Agency Theory and Stewardship Theory are used to analyse the relative performance of different forms of privatisation of water infrastructure, which further enriched the understanding of previously underdeveloped aspects of both theories. Based on the prior Agency Theory literature, there were assumptions made about the behaviour of principals and agents in contracts and those which were found to be incorrect in the context of contracts between modern governments and private organisations. Thus, the Agency theory was extended to include steward-like behaviour of an agent and the Stewardship Theory which was developed through the contractual relationship which promotes the sense of responsibility to the principal (Mills, 2014). Therefore, alliance, joint venture and Build Own Operate Transfer (BOOT) forms of privatisation were found to achieve stewardship of the water infrastructure.

Similarly, Van Puyvelde et al. (2012) conducted a research on integrating agency theory with stakeholder and stewardship theories, focusing on the governance of non-profit organisations. The purpose of the research was to provide a more comprehensive principal–agent theory of non-profit organisations by combining agency theory with aspects of stakeholder theory, stewardship theory, and empirical literature on the governance and management of non-profit organisations. First, the use of a stakeholder perspective allowed van Puyvelde et al. (2012) to identify the principals of a non-profit organisation and to divide non-profit principal–agent relationships into different categories. The research proceeded to discuss the assumptions and prescriptions of agency theory and stewardship theory and suggest that a complementary use of these theories can contribute to the research of principal–agent relationships. Through the discussion of empirical literature from a stewardship–agency perspective, Van Puyvelde et al. (2012) are able to address issues of non-profit accountability. We conclude by giving suggestions for further research and by stressing the importance of a recruitment policy to avoid internal agency problems.

2.5 Conclusion

In this chapter, Agency and Stewardship Theoretical Frameworks were discussed in different contexts. Both theories are applicable for this research since the government of South Africa (stewards) serves the role of providing water to members of the public (principal). Therefore, Agency and Stewardship theoretical frameworks form the foundation for this research. The following chapter presents the literature review addressing the status of water infrastructure and water provision within the context of developing economies, as well as the impact of infrastructure maintenance on water quality in South African context.

CHAPTER 3:

WATER INFRASTRUCTURE

3.1 Introduction

This literature review addresses the status of water infrastructure and water provision within the context of developing economies. It also presents literature on the impact of climate change on water availability and water provision, water infrastructure maintenance and management practices, and the impact of infrastructure maintenance on water quality in developing counties including South Africa.

3.2 Aspects of water infrastructure in developing economies

Nearly 80% of the world's population is exposed to high levels of threat to water security (Vörösmarty et al., 2010; Famiglietti, 2014). Investment in water technology enables developed nations to offset high stressor levels without remedying their underlying causes of climate change, whereas less developed nations remain vulnerable to climate change impacts (Granit et al., 2014; Jones et al., 2014; Vörösmarty et al., 2010). This suggests that a lack of precautionary investment has a potential to endanger biodiversity, with habitats associated with 65% of continental discharge classified as moderately to highly threatened (Vörösmarty et al., 2010; Granit et al., 2014).

For developing countries such as Africa and India, essential requirements for socio-economic growth and sustainable development require the provision of efficient, reliable and affordable infrastructure services, such as water and sanitation, power, transport and telecommunications. Thus the availability of efficient water infrastructure services is an important determining factor for economic growth. Furthermore, access to affordable infrastructure services for consumption purposes serves to improve household welfare, particularly among the poor (Yang et al., 2013; Wichelns, 2013; Kehler, 2013). Although the importance of the water infrastructure financing is emphasised by most researchers, regrettably, the potential contribution of water infrastructure to economic growth and poverty reduction has not been fully realised in many developing countries (Marlow, 2013; Vörösmarty et al., 2010; Granit et al., 2014; Jones et al., 2014). Consequently, existing water infrastructure and services fall far

short of the requirements due to lack of financing for water infrastructure development (Jones et al., 2014; Marlow et al., 2013; Vörösmarty et al., 2010).

Strategies for community water supply and sanitation programmes in developing countries require an understanding of local context with regards to problems, achievable goals, beneficial impacts and the factors which determine sustainability (Hutchings et al., 2015; Carter et al., 1999). Most developing countries are confronted with low-impact water and sanitation programmes and many systems break down, and where limited impacts are achievable, there is a limited increased in investment (Hutchings et al., 2015; Chan et al., 2014; Carter et al., 1999).

Infrastructure has been responsible for more than half of Africa's recent improved growth performance and has the potential to contribute even more in the future. Accordingly, Africa's infrastructure lags behind those of other developing countries and its economic geography presents a particular challenge for the region's infrastructure development (Foster and Briceño-Garmendia, 2010; Eberhard and Shkaratan, 2012; Page, 2012). African infrastructure services are expensive compared to that of other developing countries and the indirect costs related to infrastructure and services account for a relatively high share of firms' costs in poor African countries, presenting a competitive burden on African corporations and poor communities (Chan et al., 2014; Estache, 2014; Eifert et al., 2008). The infrastructure challenge varies greatly by country type, where fragile states face an impossible burden and resource-rich countries lag despite their wealth. A large share of Africa's water infrastructure is domestically financed, with the central government budget being the main driver of infrastructure investment (Eberhard and Shkaratan, 2012; Foster and Briceño-Garmendia, 2008; Bhattacharya et al., 2012).

Water infrastructure does not only contribute to economic growth, but it is also an important input to human development (Kusharjanto and Kim, 2011; Sapkota, 2014). It cannot contribute to improving the quality of life of millions of people unless it is part of an overall framework for development, economic growth, social equity and environmental protection. Therefore, the absence of water infrastructure has an inescapable influence on poverty, although it is not the only factor responsible for lifting people from poverty (Tortajada, 2014; Kusharjanto and Kim, 2011; Sapkota, 2014). Therefore, safe and convenient water supplies save time and arrest the spread of a

range of serious water borne diseases including diarrhoea, which is a leading cause of infant mortality and malnutrition (Ojuri, 2013). Africa's water resources are abundant, however, due to the absence of water storage and distribution infrastructure, they are grossly underutilised (Foster and Briceño-Garmendia, 2010; Marlow et al., 2013; Vörösmarty et al., 2010). Thus, the increased impact of climate change resulting in unpredictable natural events such as floods and droughts, creates a need for significant expansion of water storage capacity for poor rural communities in the long run in Africa (Grey et al., 2013; Ojuri, 2013; Tortajada, 2014). The cost of expanding water storage is extremely high in relation to the size of Africa's economies, suggesting the phasing of investments, with initial focus on achieving water security for key growth poles (Cosgrove and Rijsberman, 2014; Marlow et al., 2013; Vörösmarty et al., 2010). The price of the water services provided is also exceptionally high by global standards. The tariffs paid in Africa are several multiples of those paid in other parts of the developing world (Marlow et al., 2013; Vörösmarty et al., 2010). As a result, the public sector remains the dominant source of finance for water and other services in most states. Public investment is largely tax financed and executed through central government budgets, whereas the operating and maintenance expenditure is largely financed from user charges and executed through state owned enterprises (Bhattacharya et al., 2012; Eberhard and Shkaratan, 2012; Foster and Briceño-Garmendia, 2010).

Africa's water utilities present very high inefficiency in distribution losses, under-collection of revenues and overstaffing (Foster and Briceño-Garmendia, 2010). Consequently, utilities often collect only 70–90 percent of billed revenues and approximately 40 percent of those connected to utility services do not appear to be paying for them. Furthermore, an average of $4 billion a year of revenues are uncollected because of underpricing of power and water amounts. Thus the lack of effective operation and poor monitoring have an impact on revenue collection, resulting in reduced amounts for further water infrastructure development. About 60 percent of the funding gap relates to power, while the remainder relates to water and irrigation. Relative to the size of economies, by far the largest financing gaps are in the energy, transport and water sectors of fragile states (Foster and Briceño-Garmendia, 2010). Universal access to infrastructure services remains distant for most African countries. The vast majority of African households today lack access to piped water

and sewerage services for their communities (Kehler, 2013; Grey et al., 2013; Ojuri, 2013; Tortajada, 2014). Poor communities have resorted to adopt lower-cost technologies for water and sanitation by adopting lower-end solutions for water and sanitation such as stand posts, improved latrines and rainwater harvesting (Foster & Briceño-Garmendia, 2010).

3.3 South African water infrastructure

South Africa is experiencing challenges with regards to access to basic services, including water related services, which are largely attributed to water infrastructure maintenance backlogs and poor asset management within water utilities (Miya & Grobbelaar, 2015). Thus, ensuring, maintaining and managing drinking and wastewater service quality as well as water-use efficiency is a priority for the country. Research reveal that the current reactive management approach used by water utilities proved to be unsustainable and costly due to emergency repairs and increased customer and regulatory pressures (Miya & Grobbelaar, 2015; Reichborn, 2013; Selvakumar and Tafuri, 2012). Ineffective water infrastructure management (existing infrastructure), poor planning for new infrastructure as well as poor infrastructure asset management were also characteristics of reactive management of water infrastructure in South Africa.

3.4 Effect of climate change on water infrastructure

Recent research predicts that the increasing green-house effect has an influence towards global warming, with surface temperatures impacting on the hydrological cycles, particularly in regions where water supply is currently dominated by melting snow or ice (Baron et al., 2013; Sorg et al., 2012; Immerzeel et al., 2012). On the contrary, in warmer areas, less winter precipitation falls as snow and the melting of winter snow occur earlier in spring (Huang et al., 2012; Intergovernmental Panel on Climate Change, 2014). Thus, where storage capacities are not sufficient, much of the winter runoff was immediately be lost to the oceans (Teutschbein & Seibert, 2012). Consequently, hydrological models predict with high confidence that climate change has the potential to severely reduce the reliability of water resources over the next few decades (Haddeland et al., 2014). In addition, renewable water resources was affected by projected changes in precipitation patterns, temperature and other climate variables (Schewe et al., 2014). In addition, it is also expected that future population

increase could exert pressure on available water resources. Hence, global hydrological models which have been used to synthesise the current knowledge about climate change impact on water resources, revealed that climate change is likely to exacerbate regional and global water scarcity considerably (Schewe et al., 2014; Wang et al., 2014). Consequently, water scarcity already severely impairs food security and economic prosperity in many countries today (Intergovernmental Panel on Climate Change, 2014; Griggs et al., 2013). Climate change adds another layer of uncertainty to the complex issue of urban water infrastructure provision. Water infrastructure, urban drainage and flood protection have a typical lifetime of 30–200 years and their continuing performance is very sensitive to climate change (Hall et al., 2012). Therefore, investment decisions for such systems are frequently based on impact assessments, such as a specified climate change scenario, in order to identify a singular optimal adaptive strategy (Gersonius et al., 2013). However, recent institutional configurations surrounding infrastructure investments are considered inflexible and inadequate to deal with climate uncertainty.

While the choice of an optimal investment decision for any diverse group of stakeholders is already difficult, the presence of climate uncertainties further challenges the decision-making framework by questioning the robustness of all supposedly optimal solutions (Schewe et al., 2014; Wang et al., 2014; Hallegatte et al., 2012). Based on the assumption that climate change and other deep uncertainties are inevitable over time, the existing decision-making methodologies that are able to deal with climate-related uncertainty, such as: cost-benefit analysis under uncertainty, cost-benefit analysis with real options, robust decision making, and climate informed decision analysis, are being considered as suitable tools in a given context (Hall et al., 2012; Gersonius et al., 2013). Because climate change also plays an important role in determining future water availability, it is important for water users to reconsider how water is used and managed. Therefore, future water security necessitates improved and updated local water management planning and adaptation strategies (Wheeler et al., 2013; Schewe et al., 2014; Wang et al., 2014). Many researchers expect climate change to intensify in the form of extreme droughts and floods (Taylor et al., 2013). Thus, water authorities are compelled to consider alternative water resources other than the usual sources such as rivers and dams. Therefore, during drought periods, ground water serves as a strategic source of water for arid and semi-arid countries.

Groundwater is an alternative source of potable water in the absence of surface or tap water and it plays an important role in water and food security (Taylor et al., 2013). The global groundwater abstraction is approximately 35% and 42% by the domestic and irrigation sectors respectively (Siebert et al., 2010). Groundwater is known as a more reliable and safer water source when compared to surface water, because the use of it is not limited by seasonal or inter-annual flow variations (Cosgrove et al., 2014; Taylor et al., 2013; Siebert et al., 2010). In addition, it is relatively less polluted from anthropogenic activities when compared to surface water. As a result of climate change, surface water flow is increasingly becoming temporary, leading to higher demands for groundwater (Taylor et al., 2013). This phenomenon is more prevalent in some arid and semi-arid regions where intensive irrigation has led to over-abstraction of groundwater, resulting in increased groundwater depletion (Louma et al., 2013; Taylor et al., 2013; Siebert et al., 2010). Groundwater globally contributes 36%, 27% and 42% for domestic, manufacturing, and irrigation sector water (Döll et al., 2012; Luoma et al., 2013). Therefore, if groundwater levels decrease due to extensive use, the resource becomes less available, thus compelling additional surface water resources to be used to replenish it. Therefore, decreased ground water levels also affect surface water users which are very likely to suffer from concurrent decreases of surface water availability due to climate change (Taylor et al., 2013; Luoma et al., 2013). Subsequently, the resulting economic effects of decreased groundwater availability may result in increased costs for water delivery (Döll et al., 2012; Taylor et al., 2013; Luoma et al., 2013).

Notably, the dynamics of the groundwater-surface water interaction are different in areas along the coastal areas (Siebert et al., 2010; Wada et al., 2014; Luoma et al., 2013). Increased groundwater recharge can affect people. For instance, if the groundwater table rises above critical levels, it could damage the basements of public or private infrastructure and buildings or it could soak the agricultural soil which would then require artificial drainage (Taylor et al., 2013; Luoma et al., 2013; Wada et al., 2014). Therefore, over-pumping of wells along the coastline causes a lower groundwater level and it induces more sea water intrusions into the aquifer. In addition, storm surges, which may result from natural disasters, pose a risk for groundwater quality and water intake infrastructure (Louma et al., 2013).

3.5 Water provision in developing economies

Protecting the world's freshwater resources requires diagnosing threats over a broad range of scales, from global to local. Nearly 80% of the world's population is exposed to high levels of threat to water security (Famiglietti, 2014; Vörösmarty et al., 2010; Wang et al., 2014). Massive investment in water technology enables rich nations to offset high stressor levels without remedying their underlying causes, whereas less wealthy nations remain vulnerable (Wheeler et al., 2013; Schewe et al., 2014; Wang et al., 2014). Similarly, lack of precautionary investment jeopardises biodiversity, with habitats associated with 65% of continental discharge classified as moderately to highly threatened (Granit et al., 2014; Jones et al., 2014; Famiglietti, 2014; Vörösmarty et al., 2010).

The World Bank Development presented a report on infrastructure for development and investments in public utilities (power, piped gas, telecommunications, water supply, sanitation and sewerage, and solid waste collection and disposal), public works (major dam and canal works for irrigation, as well as roads), and other transportation sectors (railways, urban transport, ports and waterways and airports) (World Bank,1994). Accordingly, infrastructure services represent a large share of the economy, accounting for value-added of roughly 7% to 11% of GDP, with transport comprising about 5% to 8% of total employment. Public infrastructure investment ranges from 2% to 8% (and averages 4%) of GDP. For developing countries, infrastructure typically represents about 20% of total investment and 40% to 60% of public investment. The report stated that even these ratios understate the social and economic importance of infrastructure which has strong links to growth, poverty reduction and environmental sustainability (Ruiters, 2013; World Bank, 2010; Berg et al., 2013).

The World Bank Report on Africa's Infrastructure indicates that Africa's infrastructure lags well behind that of other developing countries (World Bank, 2010). Accordingly, not only are Africa's infrastructural networks, such as water systems and power deficient in coverage, but the prices of the services provided are also exceptionally high by global standards. Thus, sub-Saharan Africa has a combined infrastructure deficit for water and sanitation of an estimated $93 billion annually. Thus, meeting

Africa's infrastructure needs calls for a very substantial programme of infrastructure investment and maintenance (Ruiters, 2013; Berg et al., 2013; World Bank, 2010; Brineco-Garmendia *et al*., 2008).

Since the adoption of the Millennium Development Goals (MDGs), the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation has reported on progress towards achieving Target 7c: reducing by half the proportion of people without sustainable access to safe drinking water and basic sanitation (United Nations International Children's Emergency Fund, 2012). This report contains the welcome announcement that, as of 2010, the target for drinking water has been met. Accordingly, since 1990, more than 2 billion people have gained access to improved drinking water sources and the proportion of the global population still using unimproved sources is estimated at only 11 per cent. Although this tremendous achievement should be applauded, much work remains to be done. For instance, there are still 780 million people without access to an improved drinking water source and even though 1.8 billion people have gained access to improved sanitation since 1990, the world remains off centre for the sanitation target (Clasen, 2012).

While coverage of improved water supply sources is 90 per cent or more in Latin America and the Caribbean, Northern Africa and large parts of Asia, the sub-Saharan Africa regions are lagging behind. In sub-Saharan Africa, for instance, many rural dwellers and the poor often miss out on improvements to drinking water and sanitation. The burden of a poor water supply falls most heavily on girls and women. Reducing these disparities must therefore be prioritised (Ubuoh et al., 2012; Kehler, 2013; Van Houweling et al., 2012; and Hilson, 2012). By 2012, the coverage of drinking water and sanitation in the developing world was reported to be at 86%, but it is only 63% in countries designated as 'least developed' (Chinadaily, 2012). Similar disparities are found within countries, between the rich and poor, and between those living in rural and urban areas.

Complete information about drinking water safety is not available for global monitoring. As a result, systematic water quality analyses at the national level in all countries is prohibitively expensive and logistically complicated (United Nations International Children's Emergency Fund, 2012). Therefore, a proxy indicator for water quality was agreed upon for MDGmonitoring and it measures the proportion of the population

using ‘improved’ drinking water sources, defined as those that, by the nature of their construction, are protected from outside contamination, particularly faecal matter (Sambu and Tarhule, 2013). However, some of these sources may not be adequately maintained and therefore may not actually provide ‘safe’ drinking water. As a result, it is likely that the number of people using safe water supplies has been over-estimated (United Nations International Children's Emergency Fund, 2012).

Billions of dollars have been invested in the provision of rural water supply systems in developing countries over the past three decades (Lockwood & Smits, 2011). Although progress is being made and rates of coverage are increasing, users often find that, once installed, water supply systems are poorly maintained and eventually break down, leaving them with an unreliable and disrupted water supply (Lockwood & Smits, 2011). For diverse reasons, many developing countries are still unable to implement comprehensive wastewater treatment programmes (Qadir et al., 2010). For instance, the volume of wastewater generated by domestic, industrial and commercial sources has increased with population, urbanisation, improved living conditions and economic development (Qadir et al., 2010). Therefore, in order to improve water supply and wastewater management, improved policies on water governance and accountability, institutional dialogues and financial mechanisms are necessary. In addition, efficient management, institutional capacity and establishment of links between water delivery and sanitation sectors need to be strengthened through inter-institutional coordination (Qadir et al., 2010).

3.6 South African context of water infrastructure financing

South Africa is experiencing serious challenges with regards to access to sustainable basic services, ensuring and maintaining service quality such as drinking water quality, wastewater management, as well as water-use efficiency (Miya & Grobbelaar, 2015; Ruiters, 2013). The maintenance backlog resulting from lack of implementation of infrastructure asset management within municipalities and water utilities is responsible for the lack of service delivery. Currently, reactive management approaches proved to be unsustainable and costly due to emergency repairs and increasing customer and regulatory pressures (Ruiters, 2013; Miya & Grobbelaar, 2015; Madi, 2016).

Continuous interruptions of water service delivery and the resultant dissatisfaction of the public throughout South Africa has gained attention in various spheres of

government (Madi, 2016; Miya & Grobbelaar, 2015). These are attributable to ineffective existing water infrastructure management, poor planning for new infrastructure and notably, poor infrastructure asset management.

Past research has shown that negligence and the backlog of maintenance of water and sanitation infrastructure within municipalities are of the key challenges to provide access to water and sanitation to all citizens (Miya & Grobbelaar, 2015; Madi, 2016). The declining state of municipal wastewater and sewage treatment infrastructure in South Africa is also one of the largest contributing factors to the numerous pollution problems experienced in most parts of the country and a major contributor to health problems such as cholera outbreaks in poor communities (Gilbert et al., 2013; Pillay and Olaniran, 2016; Mema, 2009).

3.7 Conclusion

This chapter provided a review of the water infrastructure status in developing communities, notably in a South African context. Challenges associated with the impact of climate change on water availability, unsustainable water infrastructure maintenance, management practices in water utilities and the ultimate impact of poor water infrastructure maintenance on the quality of water were highlighted. Thus the importance of a proactive water infrastructure maintenance and effective management of water utilities was highlighted as a major catalyst for effective water provision in developing counties. The following chapter presents a literature review of water infrastructure financing for water provision and financial decisions used to finance water infrastructure in the context of South Africa.

CHAPTER 4

WATER INFRASTRUCTURE FINANCING AND WATER PROVISION

4.1 Introduction

This chapter addressed the importance of water infrastructure financing for water provision. In this chapter, literature on financial decisions were described based on the South African context. The opposing view to infrastructure financing as a means to water provision was also presented to demonstrate that financing infrastructure alone is not adequate to ensure water provision.

4.2 Financing decisions for water infrastructure development

Historically, governments have played the predominant role in owning and operating infrastructure facilities such as water and electricity supply facilities (Carranza et al., 2014; Ruiters, 2013; Cosgrove & Rijsberman, 2014). However, fiscal policy constraints, growing acceptance of the user-pays principle, and a recognition that there are generally greater incentives for efficiency in the private sector, have driven increased private involvement in the provision of economic and social infrastructure. Consequently, a number of countries are using different approaches to funding public infrastructure projects (Ruiters, 2013; Cosgrove & Rijsberman, 2014). Recent years have seen a decline in general government investment in infrastructure in many countries while, in some countries, the overall investment in infrastructure has remained fairly steady yet volatile (Berg, 2013; Wagenvoort et al., 2011; Chan et al., 2009).

Research shows that private investors are reluctant to invest in water infrastructure development because it is an inherently risky investment (Wagenvoort et al., 2011; Koppenjan & Enserink, 2009; Wibowo, 2006). Although investors may consider water infrastructure development as a commercial investment, water infrastructure projects are known to have weak financial returns and many of the benefits cannot readily be realised nor monetised (Wibowo, 2006). Inadequate legal and institutional frameworks present risks to the quality and reliability of water provision and the public-private partnerships may fail (Ouyahia, 2006; Wagenvoort et al., 2011; Koppenjan & Enserink, 2009). Therefore, the decision by willing investors to invest in water infrastructure is

largely determined by the rate of financial returns from the project. Thus, in order to attract private investors to water infrastructure development, governments need to improve regulatory capabilities to police the revenues and costs of the privatised water corporates (Kirkpatrick et al., 2006; Massarutto & Ermano, 2013).

Water Infrastructure investment began to decline in the 1990s as governments increased their share of public consumption expenditure in their budgets at the expense of public investment. As a result fiscal policies of budget surpluses and debt reduction have reinforced this decline (Ruiters, 2013). Government capital expenditure as a share of GDP, which was around 7.2% in the 1970s and 1980s, has fallen to a low of 3.6% of GDP (Ruiters, 2013). Business leaders, politicians, professional economists, local governments, industry and community groups have increasingly expressed concern over the decline in South Africa's infrastructure investment and have stressed the need for action (Matji and Ruiters, 2015). Professional evaluation, led by the South African Institute of Civil Engineers, has revealed the very serious problems now facing South Africa (Wall, 2011). By applying a rating on a scale of "A" to "D", it was revealed that the water infrastructure class received a "D-", indicating it was in a serious condition and needed urgent attention, although sufficient for South Africa's current and immediate future needs.

Many decisions concerning long-lived investments already need to take into account climate change. Due to the rate and impact of climate change, new infrastructure should be able to cope with increased climate variations, which makes design and construction more difficult and expensive respectively. Additionally, due to climate uncertainty, it is impossible to directly use the output of a single climate model as an input for infrastructure design. Instead, optimisation based on multi-model climate predictions suggests that future water infrastructure models should be more robust to possible changes in climatic conditions (Ghile et al., 2014; Javeline, 2014). This implies that users of climate information must also adapt the uncertainty-management methods as applied to exchange rates or R&D outcomes. Moreover, adaptation–mitigation interactions also call for integrated design and assessment of adaptation and mitigation policies, which are often developed by distinct communities (Hallegatte, 2009).

Unfortunately, water infrastructure projects often do not benefit the poor communities who cannot afford to pay for water services rendered by the private sector (Bakker, 2013; Foster & Briceño-Garmendia, 2010). Research indicates that customers are less educated about the funding gap faced by water utilities, why it exists and why it is growing, and this promotes resistance and unwillingness to pay the tariffs for water. Therefore, regardless of what method is chosen by a utility to address their infrastructure needs, it is important that consumers/customers understand and appreciate the challenges presented by the existing financial gap, thus promoting their willingness to pay for municipal services.

In the light of the above, a wide range of financing models which are suitable for both investors and governments exists, and these include direct or indirect investment, foreign aid, loans and guarantees. (Head, 2006; Ruiters, 2013; Matji and Ruiters, 2015). While these models differ from each other, collectively they show the dependence that water infrastructure projects have on public support in one form or another. Although the financing of water infrastructure is desirable for effectiveness, efficiency and sustainability of water provision, affordability continues to present a challenge for some urban and rural communities (Cosgrove & Rijsberman, 2014; Snieska & Simkunaite, 2015).

4.3 The South African context

Ultimately, the ongoing operations and the repayment of capital for the infrastructure are generally funded by the specific water users through general taxation (the fiscus) or external support such as foreign donors (Misi, 2013; Jonga, 2012). The source and viability of this funding is a critical consideration for a specific infrastructure project Thus, various sources of water infrastructure financing range from public and private sectors, as well as donor sources. Notably, a specific project may be financed using a combination of funding sources, depending on the purpose and nature of the infrastructure, as well as the institutional option that is used to enable the financing (DWA, 2013). For the purpose of this research, the following sources of infrastructure financing are briefly reviewed below, namely: Fiscal Support (National Revenue Fund), Commercial Finance through Loans and Bonds, Equity Investment, and Donor Support and Green Funds.

4.3.1 Fiscal support (National Revenue Fund)

Globally, most water resources infrastructure is financed through the fiscus which is often supported by donor transfers in the developing world. For the South African water sector, the fiscus serves as an important source of finance for socio-economic development requirements (DWA, 2012; Ruiters, 2013). All decisions to finance water resources infrastructure from the fiscus occur within national budgetary constraints. There is always a trade-off between government's developmental priorities and considerations in terms of government's infrastructure investment programme (DWA, 2012). Water resources infrastructure funds appropriation would strictly be channelled through DWA's budget. However, fiscal financing of the expansion or refurbishment of more water services-related infrastructure could also be channelled to municipalities through other infrastructure investment/grant programmes (Gay & Sinha, 2014; Ruiters, 2013). Therefore, public sector institutions may build capital reserves though tariffs that are designed to exceed costs, which are intended to be used for infrastructure expansion, upgrading or refurbishment. For instance, most Water Boards have built significant reserves in their bulk tariffs for expansion or to meet interest cover requirements on existing debt and a few Water User Associations (WUAs) have built reserves for rehabilitation of existing schemes.

4.3.2 Commercial finance through loans and bonds

The EPA and the American Water Works Association estimate that the investment needed to update or replace existing water and wastewater systems over the next 20 years is in the hundreds of billions of dollars in America (Cohen, 2012). At the same time, the economic crisis has reduced the financial resources of the South African state-owned water and wastewater utilities has eroded sources of public financing (Cosgrove & Rijsberman, 2014). The municipal bond market which was once a major source of funding for water infrastructure projects, remains a viable option for large cities, however, it may be difficult for rural communities to access (Collier & Cust, 2015). A depressed economy continues to strain the budgets of state and local governments, which has resulted in a few high-profile municipal bankruptcies. As a result, many providers of bond insurance have exited the market (Skeel, 2013). For those that remain, rates have increased so dramatically that it has become

unattainable for small communities and investors have a limited appetite to invest in bonds without this credit enhancement (Temin & Vines, 2013).

The growth of any economy is dependent on successful implementation of infrastructure projects. However, infrastructure development is linked to availability of equity and debt funds to finance these projects. Therefore, bond finance holds tremendous potential for future water infrastructure investment. As the bedrock of water infrastructure finance, bonds have been a traditional source of water funding for infrastructure development and expansions for many countries, thus reducing the cost of capital and financial risk (Milford et al., 2014).

The critical requirement for loans and bonds is the sustained income stream that the associated asset/s can generate to repay the capital and interest. Importantly, the cost of this capital (interest rate) depends on the estimated investment risk, which considers aspects from sovereign and exchange risk, through the approach to developing and managing the project asset by the implementing agent, to the reliability of the income associated with the nature of water users/customers or implied cash flow guarantees (Gatti, 2013).

Various instruments may be used to raise this capital, from commercial bank loans to dedicated bonds (Obay, 2014). The selection of these instruments depends upon the nature of the project, as well as the mandate, balance sheet and credibility of the water institution raising the debt. Development banks may also provide debt, either at commercial interest rates or through reduced-interest “soft” loans, particularly for socially or environmentally beneficial projects (Segupta et al., 2015). On the contrary, hand, development banks and financial institutions have relatively well developed public sector infrastructure risk management protocols, therefore, commercial financiers often rely on these agencies to scope and mitigate lending risks.

Institutional debt must be raised by mandated public entities or special purpose vehicles, typically with the concurrence of the Minister of Finance. There are two fundamentally different approaches that may be adopted, namely (i) to raise specific debt on a ring-fenced project basis against the expected income stream for that project, or (ii) to raise general debt for one or more projects against the entity’s balance sheet and associated total net income stream from multiple projects (DWA, 2013).

In South Africa, for instance, the TCTA has been the primary vehicle for raising ring-fenced project-specific finance for national water resources infrastructure, with an implicit guarantee from the Department of Water and Sanitation to collect and repay the debt. At the same time, Water Boards also raise capital from commercial sources against their projected income, while some WUA have accessed capital finance against surety by the farmers (DWA, 2012).

4.3.3 Equity investment

Money that is invested in a firm by its owner(s) or holder(s) of common stock (ordinary shares), but which is not returned in the normal course of the business is referred to as equity investment. Therefore, investors recover the invested money only when they sell their shareholdings to other investors, or when the assets of the firm are liquidated and proceeds distributed among them after satisfying the firm's obligations (BusinessDictionary.com, 2017). Equity investment by the private sector may be through a public-private partnership (PPP) or an entirely private concession. In the extreme, equity may include funds buying equity in a project or public utility through to entirely private development initiatives. The purpose is to share the risk of investment and return, but requires that the private investor has more commercial control over the investment, as well as development and operating decisions to manage this risk (Cosgrove & Rijsberman, 2014). Equity investment models are extensively used internationally for water services (Ruiters, 2013). They require the establishment of a special purpose vehicle with the relevant equity staked or may be implemented by an existing private utility for full concessions (Della Croce & Yermo, 2013). They tend to be project based, reflecting the capital (equity) required for development of infrastructure.

However, project finance which is primarily used to finance public private partnerships (PPPs) has faced deteriorating credit conditions during the financial crisis. This has ultimately decreased the competitiveness of PPPs compared to traditional public procurement (Busse, 2014). None the less, in South Africa it is worth noting that equity partnerships have been implemented for the non-conventional water services related infrastructure, such as demand management interventions and effluent treatment (and reuse), and could be a source of financing for local desalination, hydropower and water

quality mitigation projects without involving national strategic infrastructure (DWA, 2012).

4.3.4 Donor support and green funds

There were several climate funds already in operation before the establishment of the Green Climate Fund (GCF). There are also climate funds relevant for climate change activities in Africa. For instance, the African Green Revolution is starting to gain momentum and there is now optimism about sub-Saharan Africa's ability to rapidly increase its economic productivity. As a result, there is no doubt that sub-Saharan Africa can greatly improve food security with an ecologically-sound African Green Revolution supported by science-based policies, community mobilisation, gender empowerment and effective governance (Sanchez et al., 2009).

Other countries are beginning to implement similar efforts and they require novel financial mechanisms from the donor community to adequately support them (Afful-Koomson, 2015). The projects financed by climate funds are predominantly small-scale with high transaction costs (Sanchez et al., 2009). The average amount of GCF approved projects in Africa is US$7.21 million, and over 95% of these projects are funded by grants (Afful-Koomson, 2015). In order to enhance scalability of projects and predictability of funds, African countries have to work with the GCF to diversify their financial instruments away from grants to loans and private capital to finance medium- and large-scale projects. African countries should rally behind a position for 'additionality' of financial flows from the GCF that is realistic (Afful-Koomson, 2015).

There is support provided by bilateral and multilateral donors for private sector participation in developing countries' infrastructure. Official development finance (ODF) for infrastructure development is increasing in developing communities. A sizable proportion of development finance is distributed by bilateral and multilateral development finance institutions (DFIs) to support the private sector through loans and equity (Miyamoto & Biousse, 2014). However, almost 70% of ODI is directed to infrastructure in upper middle income countries, where the domestic financial sector might be relatively well developed. In terms of sectors, 60% of support to the private sector goes to energy, water and other essential infrastructure requirements (Miyamoto & Biousse, 2014). Export credit agencies also provide a significant amount of financing to developing countries' infrastructure. Donors further provide about 15%

of funding to improve the enabling environment for investment by building the capacity of partner government ministries, public-private-partnership units, regional organisations, and/or local administrations (Miyamoto & Biousse, 2014).

Infrastructure development can take place outside formal government involvement through the successful implementation of self-help projects by local residents. In Egypt, for instance, residents have organised themselves to gain access to water infrastructure services, through negotiations, collaboration, or working with the local administration to bring water and sanitation services to their neighbourhoods. They also use organisational and financing strategies, particularly self-funding.

The community contributions to infrastructure development in informal areas are an essential component of any feasible strategy to meet the need for such services in a timely fashion. Although such a feasible strategy would enable the needs for basic services in rapidly growing informal areas to be met, community members still require governments to consider alternative approaches that partner with local communities and prioritise essential infrastructure needs, integration of informal communities into the urban fabric, and social justice. In addition, this strategy can advance sustainable development in Egypt and other developing and transitional countries, but it will require building government capacity for outcome-oriented community partnering and greater regulatory flexibility (Bremer & Bhuiyan, 2014).

While South Africa does not receive significant donor support for water infrastructure development, this needs to be considered. In particular, there are opportunities under the green and climate adaptation funding mechanisms that may be used to access capital for the additional costs of making infrastructure resilient to climate change and more environmentally sustainable. This area of capital financing needs more attention for the South African context, particularly given the South African negotiating position of not requesting these funds (Gay & Sinha, 2014).

The strength and integrity of a nation's water infrastructure is critical to its long-term health. Though the financial cost of upgrading or replacing infrastructure is overwhelming, the cost of ignoring it may be disastrous (DWA, 2012). A number of smaller communities are choosing to bypass the issue entirely by outsourcing their needs to larger rural water systems or contract operators but this is not always a viable option. Therefore, water utility administrators must look carefully at the financial

alternatives available to them and balance the pros and cons of each against the needs and priorities of their systems. Government funding is far from certain and the process of obtaining it can add significant length to a project's timeline, yet it often offers the best financial terms. Conversley, interest rates for private funding are often higher but borrowing through a commercial lender can significantly increase speed to market. The creative combination of public and private financing may offer the best of both worlds, helping to ensure the future of our nation's water infrastructure.

In the developing world, climate-infrastructure mismatches are likely to reduce economic growth through low rates of electricity production or irregular agricultural harvests while wasting scarce investment capital. Ecologically poorly designed water infrastructure is likely to reduce the inherent resilience and adaptive capacity of these nations' ecosystems, permanently altering lakes, rivers, soils and fisheries. Nearly 80% of the world’s population is exposed to high levels of threat to water security. Massive investment in water technology enables rich nations to offset high stressor levels without remedying their underlying causes, whereas less wealthy nations remain vulnerable. A similar lack of precautionary investment jeopardises biodiversity, with habitats associated with 65% of continental discharge classified as moderately to highly threatened. Climate-infrastructure mismatches may actually make poor nations even poorer (Vörösmarty et al., 2010).

4.4 Water infrastructure financing and water provision

Financial investment in water infrastructure is important for sustainable water supply and for the renewal of aging wastewater treatment infrastructure and socio-economic development of poor communities (Gleick & Ajami, 2014; Hering et al., 2013; Hanjra & Qureshi, 2010). Governments are traditionally responsible for shaping water infrastructure investment in their countries (Carranza et al., 2014; Ruiters, 2013; Cosgrove & Rijsberman, 2014). Although local governments are constitutionally empowered to generate revenue for water infrastructure development, operation and maintenance, however, high levels of poverty prohibit some water users from paying the water tariffs (Sahasranaman, 2012; Awortwi, 2010). As a result, poor cost recovery for water services by local government often leads to the injection of subsidies from national government, thus burdening taxpayers all the more (Proost et al., 2011; Banerjee et al., 2010).

Many emerging markets and all low-income countries require a major increase in infrastructure investment to alleviate growth constraints, respond to urbanisation pressures and meet their crucial development, inclusion and environmental goals. The aggregate incremental investment spending required across emerging markets and developing countries is estimated at around $1 trillion a year (Romano et al., 2013), which is more than what is currently spent. Water, electricity and transport infrastructure needs are accountable for the bulk of the expenditure. As a result, the financing of these infrastructure investments is associated with commercial and physical risks, as well as large risk capital investment for the development and construction phases (Romano et al., 2013). Additionally, many projects face risks around revenue streams associated with policy uncertainties and affordability, thus making many water projects not feasible.

In developing countries, water-infrastructure projects also often face substantial macroeconomic and project level risks, with social returns often exceeding market returns due to externalities. Appropriate concession of financing and support for end-users through measures such as lifeline tariffs and direct income support may be appropriate to address these issues (Romano et al., 2013). Therefore, although some authors (Gleick & Ajami, 2014; Hering et al., 2013; and Hanjra & Qureshi, 2010) highlight the importance of water infrastructure financing, their research fails to highlight the challenges associated with operational and maintenance costs for providing water to communities. On the contrary, even though others (Sahasranaman, 2012; Awortwi, 2010; and Vyas-Doorgapersad, 2010) succeeded in highlighting the negative impact of privatising water infrastructure financing towards poor communities and their resistance towards tariff payments, they were not able to propose the most suitable solution which would ensure that privatisation of water infrastructure could provide water services at affordable costs due to a suitable financial model.

Accordingly, effective funding models are necessary for governments to address financial challenges associated with water infrastructure development (Akhmouch, 2012; Ruiters, 2013). International loans and private investments have been considered as viable alternative instruments for water infrastructure financing (Kings, 2014; Briscoe, 1999). Although Akhmouch (2012), Ruiters (2013), Hall et al., (2012) and Briscoe (1999) concur that alternative financing models could aid in alleviating the financial strain faced by most governments for sustainable water provision, they do

not specifically suggest the most suitable financial model to use for local governments with poor cost recovery systems. However, Bakker (2013) and Lobina (2005) agree that the private financial investment of public water services has been a favourable financing instrument due to its ability to enhance efficient water infrastructure financing and water provision in developing countries.

Arguably, there has been evidence recently that private infrastructure financing of water, has been unsatisfactory for investors in terms of revenue outputs (Briscoe, 1999; Banerjee et al., 2010; Chan & Effah Ameyaw, 2013). Bustamante (2005), Proost et al. (2011) and Ruiters (2013) also add that privatisation of water infrastructure has often led to increased overhead costs and water tariffs, which cannot be afforded by poor communities. Alternatively, there is evidence of communities who are willing to pay for water services provided they are involved in decision-making, operation and maintenance in order to protect their water resource (Moreno-Sanchez et al., 2012; Franceys & Gerlach, 2011). Therefore, lack of community engagement in management and decision-making processes contributes to public resistance towards tariff payment (Jackson et al., 2012). When consumers do not have an understanding of the water scarcity, challenges of water provision, the costs of water treatment, operation, maintenance and water provision, tend to resist the payment of costs associated with water provision (Jackson et al., 2012; Spaling et al., 2014). Thus, water infrastructure projects often result in weak financial returns with benefits that cannot be readily realised nor monetised by the investors (Wibowo, 2006; Tan, 2012; Effah Ameyaw & Chan, 2013).

4.5 Contrasting view on water infrastructure financing

Infrastructure financing, may not be the only vehicle to sustainable water provision. Scholars argue that many factors may equally affect sustainable water provision other than water infrastructure financing. For instance, there is a rapid paradigm shift from centralised decision-making, administrative regulation, bureaucratic allocation towards a decentralised decision-making, different economic instruments, and stakeholder participation related to water management issues (Kramer & Pahl-Wostl, 2014; Bourblanc & Blanchon, 2014).

In addition, political challenges prove to hinder sustainable water provision in most developing countries. For instance, in Uganda, the rural population's access to safe

water was affected by the changing institutional policy frameworks resulting from political reform. As a result, rural communities faced conflicting signals from old and new policies, creating uncertainty and ambiguity about responsibilities, rules and incentives for rural water provision (Harris et al., 2011; Naiga et al., 2015). Thus, ineffective water governance, uncoordinated institutional structures, poor financial management and lack of accountability are some of the challenges associated with poor water provision (Knüppe, 2011; Madrigal, 2011; Lalika et al., 2015). There is an increased recognition that most water-related strategies and policies still lack focus on improving the welfare of local communities (Lalika et al., 2015). Additionally, public involvement is increasingly becoming an essential element for decision-making processes in the water sector, as it promotes sustainable provision of water (Brown et al., 2013; Cosgrove & Rijsberman, 2014; Evans et al., 2013).

Although scholars may agree or disagree that infrastructure financing is the main driver for facilitating sustainable water provision, research shows that there are natural factors that determine sustainable water provision to water users (Baron et al., 2013; Teutschbein & Seibert, 2012). Such factors include the impact of climate change on the natural processes such as the extreme weather conditions, changes in seasons and hydrological cycles, a paradigm shift and adaptation measures towards the impact of climate on water availability for the environmental, and social and economic prosperity (Elliot et al., 2014; Griggs et al., 2013; Haddeland et al., 2014; Schewe et al., 2014).

4.6 Economically viable water supply initiatives

Africa has the lowest total water supply coverage of any region in the world. Currently about 300 million people in Africa do not have access to safe water and about 313 million have no access to sanitation. This situation exacts a heavy toll on the health and economic progress of African countries (African Development Bank, 2016). Behind the successes in providing first-time access to water in developing countries lie a number of pressing challenges to the dominant approach to rural water supply. These challenges involve community management following a demand-responsive approach and they manifest themselves in poor performance of service providers, high rates of hardware failure, and very low levels of service (Moriarty et al., 2013; African Development Bank, 2016).

In order to address these challenges, there is a need for a shift in emphasis in rural water supply in developing countries; a way from a *de-facto* focus on the provision of hardware for first-time access towards the proper use of installed hardware as the basis for universal access to rural water services is required. The shift should also involve the professionalisation of community management and/or provision of direct support to community service providers; adoption of a wider range of service delivery models than community management alone; and addressing the sustainable financing of all costs with a particular focus on financing capital maintenance (asset management) and direct support costs (Moriarty et al., 2013). In Mbire district, Zimbabwe, for instance, the sustainability of donor-funded rural water supply and sanitation was assessed in terms of the level of community participation, quality of implementation and reliability of the systems. Poor financial management mechanisms for effective borehole maintenance, poor quality of construction and lack of community participation in project planning were found to be potential threats to the sustainability of the projects (Kwangware et al., 2014).

In the face of climate change, natural disasters such as floods and hurricanes. are inevitable and often result in severe contamination of local ground and surface water resources and lack of access to affected areas due to the destruction of infrastructure (Blaikie et al., 2014; Khan et al., 2015; Uitto & Shaw, 2016). This presents a challenge for disaster relief groups to supply potable water to the affected population. Although the transportation of bottled water to affected communities would serve as a primary solution, the exercise has proved to be expensive in the absence of adequate financial aid (Loo et al*.,* 2012; Dixon et al., 2013). Hence, emergency water technologies that are flexible, mobile or portable serve as a suitable and temporary source of potable water for emergency relief (Boerm et al., 2013; Loo et al*.,* 2012; Shapiro, 2013). Thus an onsite, viable, potable water treatment technology proves to be a more sustainable solution for disaster relief in the disaster stricken areas (Loo et al., 2012; Shapiro 2013).

Given the worrying lack of access to safe drinking water in many developing countries, particularly in rural locations, onsite water treatment technology proves to offer a sustainable solution for polluted potable water. For instance, membrane water treatment technologies have the potential to remove microbiological and chemical contaminants reliably and simultaneously from a wide range of water sources (Schäfer

et al., 2014). When powered by renewable energy, these systems are autonomous and have the ability to ‘leapfrog’ over installation of traditional infrastructure for electricity and water supply to reach remote communities. General estimated costs for decentralised membrane systems are within the range of some untreated water costs in developing countries. Specific system costs, however, are very process and location dependent. The appropriateness of a successful approach thus depends partially on careful examination of these parameters.

However, the biggest hurdle to the adoption of the membrane technology in a remote location may not be cost, but rather sustainability issues such as the lack of skilled personnel for operation and maintenance, service networks, availability of spare parts, socio-economic integration and adaptive capacity of communities to transfer and develop technology appropriate to local needs and circumstances (Schäfer et al., 2014).

Infrastructure supports the way society works and the development of public infrastructure is the focus of government and public finances. For infrastructure to remain useful, maintenance is key (Bhattacharya, 2012; Lowndes and Pratchett, 2012). Unfortunately, most rural communities are faced with the challenge of drinking water supply systems which are deteriorating much faster than in urban areas (Rost et al., 2015). Much of the water supply infrastructure is out of operation and villagers are forced to set up private solutions. However, due to the poverty experienced by villagers, the local administration is unable to maintain the infrastructure and to provide a reliable water supply. This in turn causes their unwillingness to pay the water fee (Rost et al., 2015; March et al., 2013). There is, therefore, a need for an increased responsibility of all stakeholders to manage the local water supply system. It is also necessary to raise the awareness of all stakeholders, to animate them for more private dedication and to reduce mistrust and corruption (Rost et al., 2015; Batram et al., 2014; Bhattacharya, 2012; Lowndes and Pratchett, 2012).

In order to address the challenge of paying for costs for rural water supply and sanitation, the African Development Bank Group conceived the Rural Water Supply and Sanitation Initiative (RWSSI) in 2002 with the view to accelerating access to water supply and sanitation services in rural Africa to attain 66% access to water supply and sanitation by the year 2010 and 80% by 2015 respectively (African Development Bank,

2016). The achievement of the objectives of the initiative would contribute to poverty reduction and spur economic growth. The RWSSI has received backing from the international community, including the G8 Summit at Evian, the World Panel on Financing Water Infrastructure and the African Ministerial Council on Water (AMCOW) as well as several bilateral donors. The African Development Bank Group is therefore well placed to play the lead catalytic role in galvanising broad support and building partnerships to implement the RWSSI through collective action by donors, RMCs and other stakeholders (African Development Bank, 2016).

4.7 Infrastructure planning for water provision

Planning for water infrastructure is important to safeguard sustainable water provision. Water infrastructure planning should be linked to budgeting, while management should be concerned about long-term effects and up-to-date information on physical capital should be used in the decision-making process (Grigg, 2012). In a water, wastewater, or storm water utility, planning precedes design by studying facility needs. Although it should be continuous, planning may not occur until a specific event requires it, such as growth, obsolescence, regulatory controls, or a failure of some kind. Therefore, planning for water supply is driven by demand, flow rates, location of demands and the required quality of supplies (Grigg, 2012). On the contrary, economic shifts, new laws, voter swings, and financial problems can intervene in the best-laid plans and programmes compiled by governments (Pilon, 2013; DeLeo, 2013). In such cases, budgeting for water infrastructure projects is the crucial test. Once authorised, the budget becomes the official plan for the fiscal year. It is much more than just a tool for allocating money, it is also a key to management control of the organisation. Therefore, a budget process is a powerful tool for managers, going beyond fiscal accountability (Grigg, 2012).

General budgets, which used to fund much of the water infrastructure development, are shifting away from ongoing funding because of competition for government funds and decreasing funds (Wetzel, 2013). Over the past years indications are that the proportion of national budgets devoted to water infrastructure has been declining. Not only has there been a decline in the public investment, but the requirements for the investment to maintain, upgrade, and expand water infrastructure have been on the rise (Grigg, 2012). Thus a gap has developed between what is needed to bring water

infrastructure to satisfactory levels and current expenditures on this infrastructure. This scenario, ultimately, raises the following critical questions in the area of water infrastructure financing: Who pays for what? What the scale of financing is? Is financing protected? What are the venues for accessing capital? Water systems typically acquire funds to maintain and expand service through the general budget, local budgets, consumers, taxpayers and the system operator (Grigg, 2012). As a result, most developing countries often look at the private sector to fill this financing gap in the water sector. Unfortunately, the private sector has not been able to meet the demands of huge investments in the water sector on its own. There is evidence that a very small portion of private investments has been made in the water sector of developing countries.

Intensified urbanisation and continuous growth of cities in developing economies have become a major source of demand for additional water services. Therefore, efficient delivery and access to water services depend on much more than water infrastructure (Tortajada, 2014). They require a combination of regulatory tools; well-planned, maintained and operated infrastructure; efficient service providers; governance structures associated with water infrastructure-project financing; auditing and financial accountability; and more (Rouse, 2014). Although the infrastructure costs will be high, the benefits will be greater. Auditing is an important control function because of its independence and objectivity. No matter how careful management is, it cannot be fully objective and the outside auditor provides this objectivity. Therefore, auditing is an important tool for management, as it also provides management consulting services to make suggestions on how things can be done better (Grigg, 2012).

Water supply and wastewater infrastructures are vital for human well-being and environmental protection. However, in most developing countries, water infrastructure is reportedly aging in the face of declining funding from water consumers (Qureshi & Shah, 2014; Selvakumar & Tafuri, 2012; Coucil, 2012). In addition, climate, social and economic changes create large planning uncertainties for water infrastructure. Thus, simple projections of past water infrastructure development are no longer adequate (Lienert et al., 2015; Land & Rao, 2015; Grey et al., 2013). Water supply and wastewater infrastructures are usually forecast and planned on the basis of historic conditions. In view of increasing future dynamics and climate change, a more

participatory and long-term infrastructure planning approach is required (Lienert et al., 2015; Selvakumar & Tafuri, 2012; Coucil, 2012). For instance, population growth may occur faster or slower than expected, regulations may change and public sentiment may shift. Thus, lack of flexibility in regulations, fragmented objectives and confusing policies of water infrastructure development restrain the decision-making in the water sector.

In the light of these uncertainties, water utility managers are urged to plan for large infrastructure investments (Furlong et al., 2016; Bell, 2012). In addition, the desirable timing for the investment in water infrastructure and the magnitude of the appropriate infrastructure, have to be considered in order to meet increasing water demands (Gersonius et al., 2013; Scarborough, 2015; Gleick & Ajami, 2014). Therefore, scenario-based planning is one of the most powerful and intuitive techniques used by the water resources sector to incorporate uncertainties and to represent plausible futures (Kang & Lansey, 2012; Dong et al., 2013). Thus, considering possible futures provides flexibility and robustness to the system such that it can respond to uncertain events at reasonable costs without compromising community confidence in water utilities (Gersonius et al., 2013; Gleick & Ajami, 2014; Kang & Lansey, 2012).

Global warming and related climate changes are likely to significantly increase the weather-related risks facing human settlements. These include floods, water and power supply failures and associated economic collapse in “failed cities”. Action to help poor urban communities adapt to become more resilient to possible change must therefore be initiated, although, to date, attention has focused on mitigation rather than adaptation. Water management, which will be particularly affected by climate change, could provide an opportunity to initiate structured adaptation responses. Adaptation costs in the sub-Saharan urban water sector are estimated at between 10% and 20% of current overseas development assistance to the region. This research suggests that additional funding should be made available in terms of the “polluter pays” principle, and should be channeled through government budgets rather than ring-fenced climate funds. This would help ensure that “climate proofing” is mainstreamed and would be synchronous with current trends in overseas development assistance reflected in the 2005 Paris Declaration on Aid Effectiveness.

4.8 Cost implication of urbanisation on water infrastructure needs

Urbanisation, urban design, economic profile, and the productive base of the city are some of the factors that influence water conservation in cities (Saurí, 2013; and McDonald et al., 2014). Therefore, rapid urbanisation, climate change and population growth have led to increased pressure on urban water resources, particularly due to increased domestic water use (Wu & Tan, 2012; Urich et al., 2013; McDonald et al., 2014). For example, in Shandong, China, great changes in water resources such as groundwater depletion and reduced water table, rivers and springs drying up, seawater intrusion, and water quality decline have occurred (Wu and Tan, 2012). Therefore, even in the presence of water infrastructure development, without a sustainable water availability, it is impossible to ensure sustainable water provision to users (Gleick and Ajami, 2014; Corgrove and Rijsberman, 2014; Bgardi et al., 2012).

Thus, in order to develop urban water infrastructure which is more adaptable to these challenges, new integrated water resource management strategies are recommended in order to achieve sustainable urbanisation (Giacomoni et al., 2013; Corgrove and Rijsberman, 2014; Srinivasan et al., 2013). These include, but are not limited to, the construction of inter-city/catchment water resource networks, planning urbanisation based on local water conditions, innovative water management and local ecological restoration (Wu and Tan, 2012).

Accordingly, whilst Akhmouch (2012), Ruiters (2013) and Kings (2014), agree that infrastructure financing is fundamental for sustainable water provision, recent research proved that other factors such as policy reform, governance and accountability could negatively affect sustainable water provision (Saleth & Dinar, 1999; Kramer & Pahl-Wostl, 2014; Bourblanc & Blanchon, 2014; Lalika et al., 2015). Although previous researchers have studied various factors that influence water provision, little previous research has specifically focussed on infrastructure finance while considering water governance and accountability indicators for sustainable water provision in the context of South Africa, which is a gap that this research intends to bridge.

4.9 Conclusion

This chapter highlighted the importance of water infrastructure financing for water provision. The factors that influence the decision to finance water infrastructure were addressed. Various models used to finance water infrastructure in the context of South Africa were presented. Different views on the importance of water infrastructure financing were also addressed. Innovative initiatives, planning strategies and cost implications associated with water provision were also presented. In the following chapter, this research focused on the literature relevant to financial governance and water provision.

CHAPTER 5

GOVERNANCE AND WATER PROVISION

5.1 Introduction

This chapter reviewed the literature on the impact of financial governance, water governance, urbanisation, water usage and climate change adaptation planning, on water provision. Governance is about effectively implementing socially acceptable allocation and regulation and is thus intensely political (Rogers and Hall, 2003). It embraces the relationship between a society and its government and it generally involves mediating behaviour through values, norms, and where possible, through legislation. Governance encompasses laws, regulations, and institutions but it also relates to government policies and actions, to domestic activities and to networks of influence, including international market forces, the private sector and civil society (Wu et al., 2016).

5.2 Financial governance and water provision

Presently there are concerns raised by policy makers and scholarly communities about the ineffectiveness of some water governance processes (Pahl-Wostl et al., 2013; Lynch, 2012; Gupta & Pahl-Wostl, 2013). These challenges are particularly associated with poor financial governance which, in turn, impedes on effective provision of water. According to the Worldwide Governance Indicators undertaken by the World Bank, governance is expressed through various dimensions such as Voice and Accountability, Absence of Violence, Government Effectiveness, Regulatory Quality and Control of Corruption which this statistical analysis focused on (Kaufmann et al., 2009). The relationships of these dimensions to governance are discussed below.

Financial governance in water provision involves economic, social, political and administrative systems established to develop, manage and deliver water resources at various levels of society (Rogers & Hall, 2003; Cave et al., 2013; Gleick & Ajami, 2014). Over the past decade, however, policy makers and scholarly communities have raised concerns about the effectiveness of some water governance processes. There are growing challenges associated with poor financial governance (Pahl-Wostl et al., 2013; Lynch, 2016; Gupta et al., 2013) which in turn are affecting the efficient and

effective provision of water. The weakness in legislation and regulations, decentralisation of authority, monitoring and evaluation of service delivery, corruption, and public- private partnerships are some of the issues affecting the quality of financial governance in the water sector (Rouse, 2014; Earle et al., 2008). Consequently, due to poor financial governance, water related MDGs/ SDGs may not be fully realised. Thus, inadequate water provision in developing countries ensues (Mehta & Knapp, 2004; Bogardi et al., 2012; Biswas et al., 2012). Therefore, financial governance reform is necessary to enhance efficient management of water infrastructure finance in the water sector.

Water governance has traditionally been implemented bureaucratically by governments, from a national to local level. However, bureaucracy has been blamed for poor decision making processes and delayed responses to water service (Rogers & Hall, 2003; Brandt, 2014). There is evidence that local authorities still lack the capacity for effective and efficient financial governance of allocated funds (Gonzales de Asis, 2009; Horlemann & Dombrowsky, 2012; Yang et al., 2015). In some instances, weak financial governance of water infrastructure funds is reflected by under-spending and return of unused funds to national government at the end of the financial year (Gupta et al., 2013; Winpenny, 2003; Rouse, 2014). Conversely, decentralisation of financial governance of water has been suggested and found by many researchers to be fundamental for improved water infrastructure development and water provision (Van den Brandeler et al., 2014; Gleick & Ajami, 2014). Research has placed emphasis on the importance of the effectiveness of alignment and coordination between government agencies, the commercial sector as well as on the role of leadership in enhancing collaboration across these sectors and ensuring effective financial governance (Olsson & Head, 2015).

Indeed good financial governance of water on its own does not guarantee sustainable water provision to the public. Most research advocates for stakeholder engagement and accountability as an integral part of water governance matters (Henisz et al., 2014; Wehn & Evers, 2014; Akhmouch, 2012). Wehn and Evers (2014) proposed a phenomenon called ‘citizen observatories’ which enables a dialogue between citizens and decision makers, engages all stakeholders and promotes the establishment of a functional social contract between government and its citizens (Plummer & Slaymaker, 2007; Wehn & Evers, 2014). Furthermore, Akhmouch (2012) adds that stakeholder

engagement could potentially result in profound changes to weak financial governance of water. Lack of accountability is recognised by many researchers, being related to lack of water provision in rural areas in developing countries (De Palencia & Pérez-Foguet, 2011; Montgomery & Elimelech, 2007).

Although researchers such as Pahl-Wostl et al. (2013) and Henisz et al. (2014) have carried out research on the impact of financial governance on water provision, their research was limited in that it did not address the challenges of financial governance while monitoring accountability and infrastructure financing on water provision for sustainable socio-economic development in the context of South Africa, which is a gap in research this research intends to address.

5.3 Water governance and water provision

Water governance can be described as the range of economic, social, political and administrative systems established to develop, manage and deliver water resources at various levels of society (Rogers & Hall, 2003). It includes institutions and organisations with policies and practices that shape and manage water resources (Olsson & Head, 2015). Through water governance, stakeholders articulate their interests, their inputs are considered, decisions are taken and implemented, and decision-makers are therefore held accountable (Institute on Governance, 2015). Policy and scholarly communities have increasingly recognised the importance of water governance on the global scale. Although progress has been made in the achievement of international goals related to basic water provision and sanitation services, there are broader challenges facing the water sector other than securing the water supply (Kehler, 2013).

Questions have been raised by scholars about the effectiveness of some of the existing governance processes, especially in the light of population growth, unsustainable use of water resources, and climate change impacts on water resources, as well as unsustainable food and energy production (Pahl-Wostl et al., 2013). The presence of uncertainties implies that water governance is critical for water security and for the long-term sustainability of the Earth's freshwater systems. Recent debates regarding the governance dimensions of water security, including adaptive governance, polycentric governance, social learning and multi-level governance, have been reviewed (Bakker & Morinville, 2013). There is an emphasis by research on the

political and institutional dimensions of water governance, as well as the relevance of social power, which is an important aspect of the water security debate that is often overlooked. There is also an intersection, and potential synergies, between water governance perspectives and risk-based approaches to water security both locally and globally (Bakker & Morinville, 2013).

At a global level, the challenge of water governance, namely, the degree of centralised, concentrated, and hierarchical governance, has gained the attention of researchers (Gupta & Pahl-Wostl, 2013). For instance, the water ecosystem services and their impact on human well-being, the role of policies, indirect and direct drivers in influencing these services, and the administrative level(s) at which the provision of services and potential trade-offs can be addressed (Gupta & Pahl-Wostl, 2013). Although a centralised overarching governance system for water was found to be unlikely and undesirable, there is a need for a high-level think tank and leadership to develop a multinational perspective in order to promote sustainable water development (Gupta & Pahl-Wostl, 2013).

The weakness in policies, legislation and regulations, decentralisation of authority, monitoring and evaluation of service delivery, lack of civil society participation, corruption, and public private partnerships are some of the issues affecting the quality of water governance (Shah, 2014). Consequently, due to poor financial governance, the Millennium Development Goals (MDGs) for water may not be fully realised, which may lead to a lack of water provision in developing countries (United Nations Development Programme, 2006). While MDGs have failed to consider the root causes of poverty, gender inequality and the holistic nature of development, the goals made no mention of basic human rights and they failed to specifically address economic development (Kanie & and Biermann, 2017). Consequently, every country will be expected to work towards achieving the sustainable development goals (SDGs) (Wellard, 2017, Hák et al., 2016, Kanie & and Biermann, 2017). The sustainable development goals (SDGs) are a new, universal set of goals, targets and indicators that United Nations member states will be expected to use to frame their agendas and political policies over the next 15 years from 2016. The SDGs follow and expand on the millennium development goals (MDGs), which were agreed by governments in 2001 and are due to expire at the end of 2015 (Hák et al., 2016). Thus, as the MDG deadline approaches, about 1 billion people still live on less than $1.25 a day – the

World Bank measure on poverty – and more than 800 million people do not have enough food to eat (Kanie & and Biermann, 2017). Thus, in order to enhance the flow of water infrastructure finance in the water sector, financial governance reform is necessary. Similarly, responsiveness, predictability, transparency, participation, accountability and inclusiveness are qualities of good governance (Rogers & Hall, 2003). In order to avoid poor governance of water and to have good control of administrative issues of water, governance has traditionally been implemented bureaucratically by governments, from a national to local level (K'akumu, 2006).

Bureaucracy has, however, been blamed for the delayed decision making process and poor response to water service delivery at a local level (Winpenny, 2003). There is evidence that even though local water administrations receive most of the water infrastructure finance allocation from national government, they still lack the capacity for effective and efficient financial governance in managing the allocated funds (OECD, 1997). In some instances water infrastructure funds are under-spent and/or returned to the national government at the end of the financial year, which is a sign of poor financial governance (Winpenny, 2003). Thus, the lack of effective financial governance in local water institutions presents limitations for effective water provision. In order to address this limitation, the decentralisation of financial governance of water has been suggested and found to be fundamental for improved water infrastructure development and water provision (Van den Brandeler et al., 2014; Hordijk et al., 2014). Research has also placed emphasis on the importance of the effectiveness of alignment and coordination between government agencies, the commercial sector as well as the role of leadership in enhancing collaboration across these sectors (Olsson & Head, 2015). Therefore**,** good water governance is one that engages all stakeholders and promotes the establishment of a functional social contract between government and its citizens resulting in effective water service delivery (Pahl-Wostl et al., 2013).

Stakeholder consultation and engagement during decision making, management and financing of water infrastructure are fundamental for sustainable water provision (Cosgrove & Rijsberman, 2014). Research shows that stakeholder engagement has the potential to influence consumers' willingness to pay for water services and infrastructure in developing countries (Kang et al., 2012). Hence, the Integrated Water Resource Management (IWRM) approach is employed for consumer engagement in

the water sector. The IWRM approach is based on a thorough understanding of the actual water demands of water users (Benson et al., 2015). Integrated Water Resource Management also ensures that there is efficient, equitable and sustainable investment in improved water infrastructure by consumers (Akhmouch, 2012; Pahl-Wostl et al., 2013). Thus, although informed consumers tend to demonstrate their willingness to invest more money for improved water quality, the infrastructure developments are incomplete due to limited funds. Therefore, ensuring that consumers know about water-system needs is the best way to ensure public support for funding and potentially increased water tariffs (Grigg, 2012; Kang et al., 2012).

Consumers should, ideally, be involved in the water service and rate decisions that affect them (Akhmouch, 2012). A demand-driven planning approach is necessary to ensure sustainable water provision (Wehn & Evers, 2014). For instance, consumers are afforded the opportunity to weigh service improvements against increased water tariffs, thus determining the best strategy that meets their needs and fits their budget (Grigg, 2012). However, good water governance needs to go further than requirements for transparency during privatisation. Therefore, broad-based and ongoing education and communication with the public are critical functions of the water utility. It is important because of the public health and societal goods dimensions of water (Grigg, 2012). There is therefore a consensus in the water sector that openness and transparency are critical elements to success in privatisation (Akhmouch, 2012; Prabhu & Mohapatra, 2013).

5.3.1 Urbanisation and water provision

The majority of the world’s population now lives in cities. Consequently global urbanisation will continue at high speed. Thus, the world's urban population is projected to increase by more than 3 billion people between 2010 and 2050 (Buhaug & Urdal, 2013).The population increase is partly attributed to high urban fertility rates and reclassification of rural land into urban areas, resulting in rural-to-urban migration (Buhaug & Urdal, 2013). While urban populations generally enjoy a higher quality of life, many cities in the developing world have large slums with populations that are largely excluded from access to basic resources and services such as potable water and sanitation (Buhaug & Urdal, 2013). The rate of urbanisation has, in turn, outstripped the provision of urban basic water service and facilities in developing economies (Kalu et al., 2014).

The rapid growth of the cities and the immediate consequences of such growth have continued to be an issue of concern to professionals and the government. So many countries are now investing huge amounts of money in infrastructural projects, seeking a more integrated domestic market and easier access to world business. Yet they have not actually solved the problem of urbanisation and the decay of the cities' water and other infrastructures (Kalu et al., 2014). Therefore, there is agreement between researchers that urbanisation is strongly influenced by urban population density, resulting in the increased rate of local water usage (Barron et al., 2013; Kalu et al., 2014).

While there is consensus that urbanisation is one of the major trends of the 21st century in developing countries, there is debate as to whether urbanisation will increase or decrease vulnerability to droughts (Kalu et al., 2014; Buhaug & Urdal, 2013). Urban growth is increasing the demand for freshwater resources and there are concerns that the water sources of the world's large cities have never been assessed globally (McDonald et al., 2014). Therefore, there seem to be a relationship between urbanisation and water vulnerability for a fast-growing city. This relationship proves to be highly site-specific in certain areas (Srinivasan et al., 2013). As a result, some governments are considering the transformation of urban water infrastructure in response to increasing water demands and water shortages due to urbanisation.

In developing countries such as India, for instance, urbanisation has led to the urban transformation of the water system which resulted in the decentralisation of the irrigation wells and their conversion to domestic wells by private individuals and not by the municipal authority (Srinivasan et al., 2013). Furthermore, urban vulnerability to water shortages depends on a combination of several factors: the formal water infrastructure, the rate and spatial pattern of land use change, adaptation by households, and the characteristics of the ground and surface water system. For instance, in Chennai, India, households invest in private wells making them less vulnerable. However, over time and cumulatively, households make the entire region more vulnerable to water shortages. Therefore, in order to reduce water shortage vulnerability, there is a need for new forms of urban governance and planning institutions that are capable of managing both centralised actions by utilities and decentralised actions by millions of households (Srinivasan et al., 2013).

China is another example of a country that has seen the largest human migration in history and the country's rapid urbanisation has important consequences for public health (Gong et al., 2012). Based on the provincial analysis of its urbanisation trends, a shifting and accelerating rural-to-urban migration across the country has been observed, which is accompanied by a rapid increase in city size and population. Urban environmental quality, including air and water pollution, contributes to diseases both in urban and in rural areas. At the same time, the growing disease burden in urban areas is attributable to nutrition and lifestyle choices and is a major public health problem (Gong et al., 2012). There is also an increasing recognition by policy and scholarly communities that an integrated approach towards water governance is necessary in order to address water shortages (Pahl-Wostl et al., 2013). For instance, the Integrated Water Resource Management (IWRM) is a process that promotes coordinated development, management and governance of water resources in order to maximise socio-economic welfare in an equitable and sustainable manner (GWP, 2000).

Various researchers concur that urban disorder in developing cities is associated with a lack of consistent political institutions, economic shocks, and ongoing civil conflict (Buhaug & Urdal, 2013). This was evident in developing countries in Asia and sub-Saharan Africa where great rural resource scarcity was responsible for causing rural to urban migration. This has reportedly resulted in increased pressure on water services, leading to violent public unrest and conflicts over water resources in urban cities (Buhaug and Urdal, 2013). In order to overcome this challenge, the provision of adequate infrastructure in the rural communities could serve as an alternative solution towards reducing the rate of urbanisation and demand for water and related infrastructure (Kalu et al., 2014).

5.3.2 Water usage and management

There is, therefore, an agreement among water scholars and practitioners that improving water governance is essential for addressing water insecurity in developing countries (GWP, 2000; Pahl-Wostl et al., 2013). Economic and institutional development often lead to the fulfilment of basic human needs such as water and food at the expense of the environment. However, water supply and demand planning are often conducted independently of social and economic strategies for some river

catchment area (Sahin et al., 2015). Rivers in relatively good condition may exist in certain countries. However, they may be associated with poor governance regimes. This highlights the urgent need for the development of effective water governance structures alongside economic development (Pahl-Wostl et al., 2012).

Competing water users and conflicting uses of water are increasing, while the state of the aquatic environment is further declining. In addition, inequity in access to basic water and sanitation services is still an issue (Kehler, 2013). Therefore, researchers maintain that leadership, representativeness, legitimacy and comprehensiveness form a missing link in the trajectories of policy development and are some of the major reasons for ineffective global water governance (Pahl-Wostl et al., 2013).

Numerous recommendations have been put forward by various researchers for water governance reform without testing of appropriateness in diverse contexts. In the face of climate change challenges, the most persistent obstacles for the sustainable management of water resources lie in the realm of water governance (Pahl-Wostl et al., 2012). Therefore, there is evidence that a polycentric governance regime, characterised by a distribution of power and effective coordination structures, has better performance, particularly in a diverse environmental and socio-economic context (Pahl-Wostl et al., 2012). Therefore, in order to develop effective water governance, integrated governance approaches are fundamental for water provision in developing communities (Sahin et al., 2015). This is usually achieved through the development of water resource planning models. However, currently there are limited comprehensive water planning models, such as modelling urban water balances. Such models incorporate economic and social parameters such as tariff adjustment, thus creating financing capacity for investment responses to low reservoir levels. In addition, such modelling tools are essential for promoting integrated governance approaches for water provision in developing communities (Sahin et al., 2015). Planning models are required to consider the dynamics of the water supply and sanitation system in order to simulate changes to water governance. This can be achieved through the integration of supply, demand and asset management processes of water systems (Sahin et al., 2016). For example, a number of scenarios were applied to the Queensland region in Australia, demonstrating that introducing temporary drought measures, in conjunction with supply augmentation through rain-independent sources, is capable of efficiently providing water security in the future.

Therefore, reducing water demand in scarcity periods leads to the conservation of supply, thereby maintaining revenues for new water supply infrastructure development (Benson et al., 2015).

Successful modelling, however, cannot be achieved entirely without stakeholder engagement. Therefore, in the context of future uncertainty, the modelling for effective water governance should consider engaging various stakeholders from industry, government and academia, locally and abroad (Pahl-Wostl et al., 2012). When water problems extend beyond the borders of local communities, the river basin is generally seen as the most appropriate unit for analysis, hydrological planning and modelling, and initiation of institutional arrangements. Addressing water problems at the river basin level is, however, is not always sufficient. Local water issues carry a (sub) continental or even global dimension, which calls for a governance approach that comprises institutional arrangements at a trans-boundary level.

Although there is relative agreement regarding the need to develop new multi-dimensional, inclusive and plural approaches to water resource management and governance, related methodologies and tools are inadequate (Palh-Wostl et al., 2016). Part of river basin planning and management is the need to test the use of specific tools to support the conduct of participatory processes (Carmona et al., 2013; Palh-Wostl et al., 2016; Gupta, 2013). The concept of integrated water resources management and the use of water policies have been adopted as a response to these trends in different countries (Gleick and Ajami, 2014; Vörösmarty et al., 2010; Cosgrove & Rijsberman, 2014). Decision-making processes should include the interests, perceptions and values of affected stakeholders. The governance and management of water resources across boundaries, whether sub-national or international, is one of the most difficult challenges facing water managers today. The upstream misuse or diversion of groundwater or rivers can have devastating consequences for those living downstream (Gleick, 2014). In the context of trans-boundary rivers, this scenario can be a source of conflict between nations or states, particularly where water resources are scarce (Gleick, 2014; Earle, 2013). Similarly, water based-pollution can spread across borders and create disputes and a need for sound governance. Therefore, it is vital to cooperate effectively on the management of shared waters to unlock their contribution to regional sustainable development (Earle, 2013).

At a trans-boundary river basin level, where treaties govern water utilisation, particular treaty mechanisms can reduce conflict potential by fostering collaboration and accounting for change. A mechanism for coordination and collaboration at the river basin scale is a necessary element. This could be accomplished by various mechanisms ranging from informal networks to the establishment of an international commission to jointly manage water, but a mechanism for collaboration at the basin scale alone does not ensure sound water management. To better guide resource management, a number of management practices that are integral for adaptive governance exist. Key resilience principles for treaty design and adaptive governance could be applied to transboundary basins where the need and willingness for collaborative and iterative management is high (Chaffin et al., 2016). For instance, in the Okavango River basin of Namibia, this descriptive and applied approach is particularly useful for treaty negotiators, transboundary resource managers and programme developers (Chaffin et al., 2016).

Human water security is often achieved with little consideration of environmental consequences and, even when these are acknowledged, the trade-offs between Human water needs are often achieved with little consideration for the environmental impact. Even then these impacts are acknowledged, the trade-offs between human and environmental water needs are increasing in frequency and amplitude. Thus, the concept of environmental flows has continued to evolve in response to these challenges. However, the field is characterised by a limited transferability of insights, due to the prevalence of specific case study analyses and a lack of research on the governance of environmental water flows (Pahl-Wostl et al., 2013). Therefore, good water governance requires a global approach which is complementary to the river basin context. Subsequently, efficiency, equity, sustainability and security issues of water supply need to be addressed at the global scale, in a globalised world (Hoekstra, 2010). In addition, an institutional arrangement needs to be established in order to cope with the global dimension of water issues. An international protocol on full-cost water pricing and a water label for water-intensive products, water footprint quotas and the water-neutral concept are among the possible options being considered for international water governance (Hoekstra, 2010).

5.3.3 Climate change adaptation planning and water provision

Research indicates that there are context dependent factors that can influence water governance. For instance, climate change represents a major increase in uncertainty that water managers and policy makers need to integrate into water resource policy and management. Although climate change will aggravate hydrological impacts on river systems, currently high levels of water extraction remain the principal contributor to reduced river system flows. The threats of climate change and the trade-offs between water extraction and flows were examined for the Colorado, the Murray, the Orange and the Yellow Rivers. In all four basins, river outflows proved to have greatly reduced over a long period of time, resulting from increased water extraction. Such a challenge, for instance, calls for changes in governance, including sharing the variability between the environment and consumers, if the health of these rivers is to be maintained (Grafton et al., 2013).

Therefore, an ability to respond to climate change challenges proved to be strongly related to polycentric governance and innovative ways for dealing with uncertainty. A certain level of uncertainty may always exist in water resources planning, but the speed and intensity of changes in baseline conditions that climate change embodies, might require a shift in perspective. Significant climate change uncertainties, therefore, pose numerous challenges in the water governance context. The adaptive governance principles, therefore, required the proposal of policy actions across different scales of governance to better manage baseline variability and more 'unpredictable' uncertainty from climate change impacts on the society and the economy (Clarvis et al., 2014).

When the availability of a water resource varies between overabundance and extreme scarcity, water management and governance regimes must manifest flexibility and authority to adapt while maintaining legitimacy (Chaffin et al., 2016). Unfortunately, the need for adaptability often conflicts with the desire for certainty in legal and regulatory regimes and laws that fail to account for variability often result in conflict when the inevitable disturbance occurs. Therefore, collaboration among various stakeholders such as physical scientists, political actors and local leaders, is fundamental. Furthermore, when a common goal is shared among sovereign states, collaboration between and among institutions with authority to act at different scales or with respect

to different aspects of water systems is key towards achieving water resources resilience against the threats of climate change impacts.

5.4 Corruption and water provision

Corruption is measured through the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests (Kaufmann et al., 2009; Caron et al., 2012; Rose-Ackerman and Palifka, 2016). Thus, this analysis revealed that even in the presence of poor governance, corruption may not necessarily be responsible for inadequate water provision. This means there could be other factors that could contribute to poor water provision. This finding is contrary to the conventional view that poor governance and corruption both hamper water provision.

Previous literature illustrates a strong relationship between corporate governance and corruption and suggests that in countries with high levels of corruption, firms lack efficient corporate governance practices (Caron et al., 2012; Windsor, 2014). Globally, corruption has been identified as one of the major problems that have negative consequences on the socio-economic development of many nations (Kaynode et al., 2013). Thus, countries with deficient corporate governance practices and low levels of compliance to these standards breed corruption leading to a wide range of transparency dilemmas (Caron et al., 2012; Rose-Ackerman & Palifka, 2016).

Thus, if corruption is endemic, public officials, both bureaucrats and elected officials, may redesign programmes and propose public projects with few public benefits and many opportunities for private profit (Rose-Ackerman & Palifka, 2016). Corruption, which manifests through bribes, payoffs and kickbacks, is perceived as one type of government failure (Egunjobi, 2013). Therefore, efforts to promote good governance must be broader than anti-corruption campaigns. Governments may be honest but inefficient because no one has an incentive to work productively and narrow elites may capture the state and exert excess influence on policy (Rose-Ackerman, 2005). Interestingly, research revealed that public spending often does not yield the expected improvement in outcomes (Rajkumar & Swaroop, 2008). Thus the differences in the effectiveness of public spending can be largely explained by the quality of governance, particularly in the public service systems (Rajkumar & Swaroop, 2008).

5.5 Regulation and water provision

Interestingly, the results imply that poor regulation does not necessarily promote ineffective governance. Regulation is measured through the ability of the government to formulate and implement sound policies and regulations that permit and promote public and private sector development (Kaufmann et al., 2009). However, this finding is contradictory to the view of many researchers that, without effective water governance framework, water regulation will remain ineffective for water authorities (Shafir, 2013; Carrigan & Coglianese, 2011; Rose-Ackerman & Palifka, 2016). Regulation is the product of actions by decision makers and staff in government agencies, legislatures, and executive offices, as well as by representatives from businesses, advocacy groups and other nongovernmental organisations (Carrigan & Coglianese, 2011). Understanding how regulation gets made and implemented has been a persistent challenge for researchers, political scientists, economists and legal scholars (Javeline, 2014; Shafir, 2013). The process of regulating involves complicated interactions among a variety of governmental and non-governmental actors in a constantly changing environment (Carrigan & Coglianese, 2011; Xu et al., 2016).

Governance is about effectively implementing socially acceptable allocation and regulation (Rogers and Hall, 2003). It encompasses laws, regulations, institutions and it also relates to government policies (Wu et al., 2016). Regulation is therefore measured through the ability of the government to formulate and implement sound policies and regulations that permit and promote public and private sector development. (Kaufmann et al., 2009). Water resources' regulation therefore entails issues of water quality as well as to allocate quantity to users. Since the regulation of other sectorial water users such as agriculture and industry is generally very weak, preventing water pollution from agricultural, industrial and mining use is becoming increasingly important (Yang and Liu, 2010; Carrigan and Coglianese, 2011). An intense regulation is thus necessary for water utilities with a clear definition of the respective duties of the regulator and operator (Xu et al., 2016). Too often the performance of water utility operation is overshadowed by the poor governance structures that exist in society. Thus without an effective water governance framework

for water utilities, whether publicly or privately supplied, water regulation will remain ineffective (Yang and Liu, 2010; Carrigan and Coglianese, 2011; Xu et al., 2016).

5.6 Violence and water provision

Absence of violence is used as a measure of effective governance due to the perceptions of the likelihood of political instability and/or politically motivated violence is minimal in the presence of effective governance (Kaufmann et al., 2009). Thus, the nature (public service related) and impact of protests and riots could turn out to be violent and cause damage to assets or injure or detain people, particularly if these disrupt normal movement, business operations, and activity (Kaufmann et al., 2009).

Improving public service delivery is one of the biggest challenges confronting local administration in Africa. Thus, there are a number of researches that link citizens' satisfaction with public services delivery and dissatisfaction with participation in street protests in Africa. Previous research sought to gain a deeper understanding of linkages between water scarcity and societal expectations for service delivery, as well as the dynamics between water scarcity and social protests. As a result, when the expectation local citizens have, such as lack of service delivery has not been met by government, often, government officials tend to respond to demands by citizens for better performance, by disengaging themselves and shifting blame (Akinloye et al., 2014; Bhagwan, 2014). For instance, South Africa has experienced violent service delivery protests over access to basic services, such as water, electricity, housing and job opportunities, for the past few years (Langa and Kiguwa, 2013; Bhagwan, 2014). Similarly, governments of fragile and conflict-affected states, such as Iraq, regard service delivery as one of their priorities (Brinkerhoff et al., 2012).

Where water services are poor and unsatisfactory, residents often employ various strategies to disrupt the policies of the government, including marches, protests, payment boycotts, illegal reconnections, political education and test-case constitutional litigation (Morgan, 2006; Akinloye et al., 2014). Thus, poor water service delivery is an indicator of lack of progress of the governance functions. The resultant increased frustration within a public that is associated with long-standing, unresolved problems, eventually leads to disregard for the law and in some cases violent protests by people rebelling against a system they do not feel respects them (Langa and Kiguwa, 2013; Akinloye et al., 2014). These researchers therefore concur

with the observed results of this research that a relationship between the perception of governance and service related violent protests exists.

5.7 Conclusion

This chapter reviewed the literature on the impact of financial governance, water governance, urbanisation, water usage, and climate change adaptation planning. It also reviewed previous research on the impact of corruption, regulation and violence on water provision. This literature was presented in the context of South Africa. Governance was found to be influenced by corruption, regulation and violence thereby impacting on effective water provision. The subsequent chapter presents literature on the impact of financial accountability and citizen voice on water provision as well as the challenges associated with inadequate water provision in the context of South Africa.

CHAPTER 6

ACCOUNTABILITY AND WATER PROVISION

6.1 Introduction

This chapter presentes the literature review about accountability in terms of financial accountability and citizen voice and their impact on effective water provision. The concept of accountability and financial accountability for water provision was discussed in this chapter. In addition, literature on the impact of citizen voice on water provision, as well as the obstacle to accountability for water provision, monitoring the integrity of water provision and water accountability approaches is also presented in this chapter.

6.2 Accountability

Accountability exists when there is a relationship where an individual or body, and the performance of tasks or functions by that individual or body, are subject to another's oversight, direction or request that they provide information or justification for their actions (Stapenhurst and O'Brien, 2007). Adamolekun (2010) described accountability basically as holding public officials responsible for their actions. Therefore, the concept of accountability involves two distinct stages: answerability and enforcement. Answerability refers to the obligation of the government, its agencies and public officials to provide information about their decisions and actions and to justify them to the public and those institutions of accountability tasked with providing oversight. Enforcement suggests that the public or the institution responsible for accountability can sanction the offending party or remedy the contravening behavior. (Stapenhurst and O'Brien, 2007). Financial Accountability on the contrary, tells you what policies your board should adopt or has adopted to meet their responsibility for ensuring that the organization they govern is financially sound. They would then hold those who manage the organization accountable for implementing these policies (Pina et al., 2016).

Research indicates that accountability promotes effective governance and sustainable water provision (Cosgrove and Rijsberman, 2014). A number of approaches have been developed to monitor and to improve water services targeted towards those who

need it the most. These methods support local authorities with planning for water provision and can be used to hold service providers accountable for their performance.

For instance, in East Africa, Tanzania, the extensive use of mobile telephony contributed to the imagined promises of ICT, where software was developed for enhancing accountability for the rural water supply (Wesselink et al., 2015). The rural water supply proved to be a private, public and common good and through accountability, many informal mechanisms prevailed where explicit reporting was not relevant (Wesselink et al., 2015). Similarly, in the late 1990s and into the 2000s, drought conditions affected an acute water scarcity crisis across large parts of Australia. In response to this challenge, public policy emphasised demand management strategies which were examined within a large Australian university during the period (Egan, 2014). Consequently, the University staff were empowered to embark on a water accountability initiative which changed a focus from water efficiency and water principles. However, into the late 2000s, as drought conditions subsided and with a renewed focus on financial control, developments that had not established clear links to core accountability mechanisms eroded (Egan, 2014). The research demonstrates that measurement is essential to understanding patterns of water usage. There was also a need to establish links to core systems of accountability to broadly change water use behaviour. Therefore, both researches proved that innovative developments have a positive contribution towards emergent systems of water accountability (Wesselink et al., 2015; Egan, 2014).

In contrast, the lack of accountability is contributed to failure of water services and water provision in rural areas of developing countries (Moriarty et al., 2013). Thus the lack of accountability by service providers is responsible for poor service provision particularly to the poor communities (Davis, 2014). However, poor communities' accounts are occasionally checked to determine if they are paying for poor water services rendered by local authorities. Therefore, major barriers to successful water provision lie with government institutions (central and local), policies and realities of developing countries. For instance, poor service provision by the public sector is often attributed to poor skills, structures, decision-making processes, and bureaucratic procedures (Davis, 2014).

6.3 Financial accountability and water provision

According to Pina et al., (2016), financial accountability focuses on identifying relevant policies which the board of water authorities should adopt in order to meet their responsibility for ensuring that the organization they govern is financially sound. Consecuently, the buard would then hold those who manage the organization accountable for implementing these policies. The legal framework advocating financial accountability and transparency exists in every country. However, it is not always implemented as practically as expected (Gaventa & McGee, 2013; Taplin et al., 2013; Armstrong, 2005). Substantial discrepancies in financial accountability by public administrators are often reported during annual audits (World Bank, 2011; Taplin et al., 2013; Greiling & Halachmi, 2013). In Mexico, for instance, although the decentralization of public services has shown significant progress by empowering local and state governments, the transfer of greater powers to subnational governments does not necessarily mean an increase in their institutional capacities. Thus, due to the lack of institutional capacities at the subnational level, the current policy framework fails to guarantee the three basic premises that should be fulfilled by today's intergovernmental fiscal arrangements, namely: fiscal responsibility, compensatory duties and accountability (Mendoza, 2013). Similarly, although Nigeria is richly endowed with oil and gas resources, the country's continued reliance on loans from international financial institutions raises questions about the transparency and accountability of its utilisation of the huge revenues resulting from these two resources (Bakre and Lauwo, 2016). In order to attract international capital to bolster its revenue from sales of oil and gas, a huge proportion of which continues to be used corruptly, the World Bank has encouraged the Nigerian government to subscribe to neoliberal economic policies by enlisting accounting firms and privatising state-owned enterprises (Bakre & Lauwo, 2016). Therefore, although the enhanced accountability, reduced public-sector corruption, promoting market efficiency and attracting international capital are key justifications for this decision in Nigerian states, it appears to be an illusion created partly through the apparent legitimacy of accounting (Bakre & Lauwo, 2016).

The previous examples prove that the lack of accountability contributes to the failure of water services and water provision in rural areas of developing countries. Davis, (2014) agrees with the general view that a lack of accountability by service providers is responsible for poor service provision particularly to the poor communities. Yet, poor communities' accounts are frequently checked to determine if they are paying for poor water services rendered to them by local authorities. Therefore, major barriers to successful water provision lie with government institutions (central and local), policies and realities of developing countries. For instance, poor service provision by the public sector is often attributed to poor skills, structures, decision-making processes and bureaucratic procedures (Davis, 2014).

Poor water provision is also duly influenced by foreign institutions such as donors, who often misunderstand the local context into which their investments, advice and requirements are offered. In addition, donor policies tend to increasingly follow a one-size-fits-all model and are usually implemented without the consideration of the local context and reality which often differ from the theoretical perspective documented on paper (Davis, 2014). Thus, poor management and lack of accountability at decentralised local government level and subsequent opportunities for corruption, aggravate the problem of poor water provision (Carter et al., 1999). Consequently, lack of accountability is associated with lack of professionalism and work ethic in many sectors. As a result, there is a lack of independent verification of outputs and outcomes for water provision. For instance, the fact that contractors are allowed to work on the rural water supply for years without ever being held to account for their actions also presents a challenge (Rosegrant, 1997). Lack of community management is among a number of challenges associated with access to rural water supply in developing countries. It manifests itself through poor performance of service providers, high rates of hardware failure and very low levels of service (Moriarty et al., 2013).

Researchers argue that tackling these challenges requires a shift in emphasis in rural water supply in developing countries and a focus on the provision of hardware for first-time access towards the proper use of installed hardware as the basis for universal access to rural water services (Moriarty et al., 2013). The main actions required to achieve this shift include: professionalisation of community management and/or provision of direct support to community service providers; adoption of a wider range

of service delivery models than community management alone; and addressing the sustainable financing of all costs with a particular focus on financing capital maintenance (asset management) and direct support costs (Moriarty et al., 2013). Therefore, existing gaps in financial accountability in governments, often lead to lack of water service provision to communities. Accordingly, limited financial resources, weak financial accountability and increased demands for water exert pressure on the government to augment water infrastructure through the private sector (Vörösmarty et al., 2010).

Experience shows that in the absence of effective financial accountability and unsustainable water provision, governments outsource these responsibilities to the private sector. The main argument in favour of privatising financial accountability and water provision services is because the private sector is considered to have better managerial capability, stronger financial capacity and better experience for adequate water provision in developing countries (World Bank, 2012; Cosgrove & Rijsberman, 2014). Hence, there are growing trends towards water privatisation in all parts of the world (Kurniasih, 2008). By 2003, at least 55 countries had privatised water services, with the fastest privatisation occurring in East Asia in the 1990s (Prasad, 2006). The private sector was considered to have better managerial capacity, stronger financial capacity and better experience and technological capacity to solve the problems of supplying adequate water in developing countries (World Bank, 1993). Perception, however, is often unrealistic for most developing countries. For instance, in Jakarta, Indonesia, water privatisation proved to be unsuccessful due to lack of financial accountability, poor governance, regulatory and technical problems (K'akumu, 2006).

Accordingly, Nigeria which is endowed with oil and gas, continues to reliancy on loans from international financial organisations, thus raising questions about the accountability and transparency about the large revenue derived from both resources (Bakre and Lauwo, 2016). A huge proportion of the revenue from sales of oil and gas, however, continues to be used corruptly. Enhancing accountability, reducing public-sector corruption, promoting market efficiency and attracting international capital are desirable under such circumstances. However, the assumption that accounting will enhance accountability, reduce public sector corruption and promote market efficiency in privatisation and ultimately attract investment into a crony, capitalist Nigerian state,

appears to be an illusion created partly through the apparent legitimacy of accounting (Bakre & Lauwo, 2016).

Although private companies would inherently be expected to enhance financial accountability for water provision, they fail to meet desired affordable water service delivery expectations of the public sector due to high water tariffs which may not be affordable by the poor (Kurniasih, 2008; Bakker, 2010; Odaro, 2012). Furthermore, the legislative framework underpinning water privatisation in developing countries is reportedly poor and ineffective for guiding underperforming private water companies. There seems to be a lack of direction on how trustees should be held accountable for allocated funds and expenditure for water provision, which is a reflection of failure by the state to protect public interests through effective regulations (Chen, 2013; Naiga et al., 2015). This leads to enormous economic, environmental and health impacts (Maxwell, 2013; Chen, 2013; Naiga et al., 2015; Lalika et al., 2015). Therefore, effective financial accountability for water should allow members of the general public to have access to audited reports and to raise queries where need be (K'akumu, 2006).

Since the nineties, the introduction of public water service provision has exerted pressure on public sector entities to account for their water service performance in financial and non-financial terms (Greiling & Grüb, 2015). Contrary to the private sector, the accountability expectations and obligations are higher for public institutions due to public ownership and the specific public mission objectives, which are synchronous with the Stewardship Theory. There is a need for more emphasis on the linkage of citizen accountability to the sustainability reporting practices of public enterprises for water provision services (Greiling & Grüb, 2015).

Research also proves that in most developing countries the lack of community engagement initiatives in local water programmes, as well as poor communication and information dissemination of water related matters between the local authorities and community members, contribute towards poor financial accountability and lack of water provision (Emmett, 2000; Omer, 2013; Tambudzai et al., 2013;). For instance, most municipal water providers do not present annually audited reports publically, even when they are required to do so. In addition, such reports are often not widely accessible to the public other than to regulators within government (Winpenny, 2003; De Asís et al., 2009; Omer, 2013).

Water industry experts are increasingly working towards the development of a General Purpose Water Accounting (GPWA) tool to be used to report information about water rights (Chalmers et al., 2012). The GPWA has the potential to affect water policies, pricing, management and decisions to invest in water. There is a recognition by researchers that the fate of GPWA depends partly upon regulatory power and economics (Chalmers et al., 2012). As a result, GPWA has the potential to benefit various stakeholders for generating public interest in international water industries. Therefore, accounting for water can affect allocations of environmental, economic, social and other resources (Chalmers et al., 2012).

In African countries such as Kenya and Tanzania, accounting initiatives for water and other services proved to be useful for profitability, affordability and accountability in the water sector. For instance, in Ghana, policy making requires the deployment of technologies for accounting in government in order to communicate and justify divergent policies (Shiraz et al., 2007). Similarly, South African local authorities have responded to the *post-apartheid* promise of redistribution and democratisation of essential services. For instance, the Cape Town local government has adopted accounting principles for water distribution as part of the intense local government restructuring (Shiraz et al., 2007).

It is very important for local authorities to communicate with all citizens on the status of water services rendered in order to strengthen, encourage and institutionalise financial accountability in the water sector, which is in line with the Stewardship Theory. Many researchers agree that since local citizens are taxpayers, their presence ensures that local governments are financially accountable to them for water provision (Tambudzai et al., 2013; Omer, 2013). Poor financial accountability, however, is not solely responsible for lack of water provision (Pahl-Wostl et al., 2013; Lynch, 2012; Gupta et al., 2013; and Ruiters, 2013).

Research proves that there are other factors contributing to inadequate water provision, and these include, but are not limited to, lack of financial investment as well as poor financial governance (Gleick & Ajami, 2014; Hanjra & Qureshi, 2010). For instance, some municipal water providers do not produce annually audited reports and accounts publically as required. (Hering et al., 2013). As a result, such reports are not widely accessible to anyone other than regulators within government (De Asís et al.,

2009). In the context of South Africa, for instance, the Constitution of the Republic of South African makes provision for basic human rights for every person to have access to clean water and decent sanitation (The Constitution of South Africa, 1996). Thus the South African government had set a target to provide access to basic water and sanitation to all the people in South Africa by 2014. However, 5% of South Africans are currently still living without clean water and there are backlogs of providing sanitation services to approximately 11% of households (Hon. J. Zuma, 2014). In addition, at least 26% of households within formal areas lack decent sanitation services (South African Human Rights Commission, 2014). This is due to the deteriorating infrastructure, lack of technical skills, poor maintenance scheduling, inadequate water services provision and insufficient water resources (Auditor General of South Africa, 2013). Therefore, this reflects the shortcomings by government to fulfil their commitment to water and sanitation to South Africans.

Since the local government is responsible for providing water and sanitation services, in South Africa this function lies with municipalities who are classified as water services authorities. Based on the South African Auditor General's report (2013), warning signals were identified of a serious impact on municipalities' ability to provide a large portion of South Africa's population with clean water and proper sanitation. Some of these warning signals are a result of non-compliance with legislation and lack of financial accountability for water and sanitation services. The South African Auditor General's report (2013) also identified the lack of effective planning, poor setting of targets and failure by municipalities to report on the progress made as shortcomings by the municipal leadership resulting in inadequate water provision.

Although such reports are unlikely to be read by the majority of consumers, simple summaries are often delivered to consumers as part of their utility bills (De Asís et al., 2009). Equally, such information could be widely distributed to the public domain through the media and non-governmental organisations (NGOs). In addition to that, information on projects, expenditures and water infrastructure, detailing the use of financial resources, can be disseminated through simple and innovative means such as sign boards in communal areas for community members to view (Rogers et al., 2012). As a result, such approaches have the potential to inform the public about the status of water provision and to promote financial accountability in the water sector by local authorities. Although research has been conducted on the lack of financial

accountability in the water sector in other countries (World Bank, 2010; Taplin et al., 2013; Greiling & Halachmi, 2013), there is limited research focusing on financial accountability in relation to sustainable water provision in the context of South Africa, which is the gap that this research intends to bridge.

6.4 Water accountability and water provision

Based on the 2004 World Development Report, there are shortfalls in making service delivery work for poor people (Flore, 2004). These shortfalls are largely attributed to the lack of capacity, poor governance and lack of accountability for water services (Bremer & Bhuiyan, 2014; K'akumu, 2006). The more service providers are held accountable for water provision by communities, the more service delivery improves, which is aligned to the Stewardship Theory (Van Puyvelde et al., 2012; Gilliland & Kim, 2014). Therefore, in order to improve the quality and coverage of public services, it is essential that the livelihoods of poor communities are empowered and enhanced through water provision (Bakker, 2013; Foster & Briceño-Garmendia, 2010).

6.4.1 Water as a basic human right

Water and sanitation are vital for the public health and there are growing calls to accept it as a basic human right and for the establishment for a rights-based framework for the water policy (Meier et al., 2013; The Constitution of South Africa, 1996; Mehta, 2014). Through international law, policymakers have increasingly regarded access to water as an independent human right. The evolution of a rights-based water and sanitation policy has reached a milestone in the United Nations (UN) General Assembly's 2010 Resolution on the Humans' Right to Water and Sanitation (Meier et al., 2013; Mehta, 2014). The opportunities created by the UN Resolution were examined for the implementation of the human rights to water and sanitation through global water governance, national water policy and water and sanitation outcomes (Meier et al., 2013).

The UN Resolution has the potential to have lasting benefits for public health (Meier et al., 2013). In order to measure the progressive realisation of the human right to water an index was proposed (Luh et al., 2013). The proposed index differs from existing measures of inequality as it measures the rate of change and not the level of

achievement and thus addresses the principle of progressive realisation that is fundamental to human rights (Luh et al., 2013). Although its application to the non-discrimination and equality component for water was demonstrated, the conceptual approach of the index could be used for all the different components of human rights (Luh et al., 2013).

In light of the above tools, there is an increasing interest in the intersection between accounting and human rights (Hazelton, 2013; Egan, 2014). Since human rights have a moral drive to foster access to water and environmental information, human rights may also serve as a catalyst for policy change specifically in terms of corporate water-related disclosures (Hazelton, 2013). Therefore, access to corporate water-related information needs to constitute human rights (Hazelton, 2013; Griffin, 2008; Sen, 2004). Therefore, if political participation is regarded as a foundation for human rights and if water is a critical subject of political debate, then water-related information, as a consequence, is required. The state is also in a position to account through the presentation of such information to the public regarding the usage and provision of water (Hazelton, 2013). However, corporate water disclosures may not necessarily be in the form of annual sustainability reports (Greiling & Grüb, 2015). On the contrary, the water usage information may also include reporting by government agencies via public databases and product labelling (Hazelton, 2013; Egan, 2014).

6.4.2 Obstacles to accountability for water provision

Informal and illegal water provision is increasingly regarded as an obstacle to water development in the world (Meehan, 2013). A bio political approach was used to argue that state authorities use illegal forms of water provision as a source of power, particularly to discipline certain spaces and sectors of the population and moreover, that such power geometries are deeply uneven (Meehan, 2013). Findings indicate that while water theft supplies a vital resource for marginalised citizens often in communal ways that exceed state power; the alternating tolerance and repression of water illegality is largely used by authorities to maintain a hydro-social order and, in effect, to control informal modes of development (Meehan, 2013).

In East Africa, the extensive use of mobile telephony contributed to the imagined promises of ICT, where software was developed for enhancing accountability for rural

water supply in Tanzania (Wesselink et al., 2015). However, the rural water supply context in Tanzania was found to be much more complex than the contexts for which it was developed. Nevertheless, rural water supply proved to be a private, public and common good, and through accountability, many informal mechanisms prevailed where explicit reporting was not relevant (Wesselink et al., 2015).

A study conducted by Egan (2014) in a large Australian university between 1999 to 2010 empowerd the university staff to change their focus from water efficiency and principles to water accountability initiatives. However, into the late 2000s, as drought conditions subsided and there was a renewed focus on financial control, and developments that had not established clear links to core accountability mechanisms were eroded (Egan, 2014). The research found that measurement play a fundamental role in understanding water usage patterns in Australian University. Furthermore, there was also a need to establish links to core systems of accountability to broadly change water use behaviour. Therefore, this research provides insight into the development, fragility and contested meaning of emergent systems of water accountability within the context of a university (Egan, 2014).

Accountability that is translated downwards to lower levels requires the vertical separation of power as well as institutional arrangements at the local level to separate powers among executive, legislative and judicial bodies. Therefore, in order to guarantee political competition, the analysis of the political environment is a fundamental step towards understanding the factors that promote discretion and accountability in the decentralisation of decision-making power in governments (Edwards et al., 2014). Legislation should also provide guidance for local authorities to achieve this goal. For instance, in Sierra Leone, the Local Government Act (LGA) provides a framework for downward accountability from government institutions to local communities regarding water and other service provision (Edward et al., 2014). For example, council meetings are required to encourage the participation of residents and community stakeholders, and the LGA mandates minutes of council meetings to be made public within fourteen days. The legislation further requires public information on notice boards to display financial and other important documents, such as development plans, tender documents and contracts, as a means to transparency and participation. However, there are reports that local councils are slow to erect notice

boards and that information on revenues and expenditures is posted only haphazardly. Furthermore, through field visits, there is no evidence of minutes of council meetings posted on information boards (Edwards et al., 2014). This proves that, although the legislative framework may exist, the goal of achieving accountability and transparency may be compromised by lack of implementation.

6.4.3 Monitoring the integrity of water provision

Monitoring of water services is part of water accountability and it informs policy and planning for national governments and the international community (Kayser et al., 2013). Currently, the international monitoring system measures the types of drinking water sources that households use. There have been calls for improved monitoring systems over several decades, some advocating the use of multiple indicators (Kayser et al., 2013). There is substantial evidence on the importance of each commonly recommended indicator, service type, safety, quantity, accessibility, reliability or continuity of service, equity, and affordability (Kayser et al., 2013).

The Millennium Development Goals established global targets for drinking water and sanitation access. Progress towards these targets, facilitated by international monitoring, has contributed to reducing the global disease burden and increasing the quality of life (Batram et al., 2014). The experiences of the MDG period generated important lessons about the strengths and limitations of current approaches to defining and monitoring access to drinking water and sanitation. International monitoring of drinking water and sanitation shapes awareness of countries' needs and informs policy, implementation and research efforts to extend and improve services (Batram et al., 2014; Sauri, 2014; Rost et al., 2015). The methods by which the Joint Monitoring Programme (JMP) of the WHO and UNICEF track access and progress are based on analysis of data from household surveys and linear regression modelling of these results over time (Batram et al., 2014). These methods provide nationally representative and internationally comparable insights into the drinking water and sanitation facilities used by populations worldwide, but they also have substantial limitations: current methods do not address water quality, equity of access, or extra-household services (Batram et al., 2014). Improved statistical methods are needed to better model temporal trends (Batram et al., 2014). Thus, in a review of the literature

on water service indicators and frameworks with an objective to informing deliberation on their relevance to national and international monitoring, substantial evidence on the importance of each commonly recommended indicator, service type, safety, quantity, accessibility, reliability or continuity of service, equity, and affordability was determined (Kayser et al., 2013).

6.4.4 Approaches to Water Accountability

A number of approaches have been developed to monitor and to improve water services targeted towards those who need it the most. These methods support local authorities with planning for water provision and can be used to hold service providers accountable for their performance. Annual reports are usually reviewed by the public to assess the performance of authorities for the delivery of services. Such reports, however, are compiled differently depending on the context and the audience for which they are presented.

In Australia, for instance, the general purpose water accounting (GPWA) approach is used for water provision reporting. The general-purpose water accounting is a method for accounting for water and water rights that has been developed by Australia's Water Accounting Standards Board (Chalmers et al., 2012). Where water accounting is defined to be a systematic process of identifying, recognising, quantifying, reporting, and assuring information about water rights or other claims to water, obligations to deliver water or rights or other claims to water are fulfilled (Chalmers et al., 2012). This is a method that accountants should recognise for its analogy with general purpose financial reporting. There are perceptions by potential users that the Australian GPWA, which employs financial accounting techniques to water, could be extended to other areas of natural resource management (Tello et al., 2016). However, it is important to acknowledge that, on its own, water accounting will not resolve any water crisis. It is a decision-making tool, not a solution. However, it can play an incredibly important part in water provision and control. After all, good decisions are usually underpinned by good information (Tello et al., 2016). Water users perceive the GPWA as a useful approach for water accounting and they believe that the benefits of using it could outweigh the costs of implementing it at a local authority level (Tello et al., 2016). The benefits of GPWA include the provision of information, accountability and to assist in decision-making about water provision by local authorities.

Hence the adoption of a financial accounting approach in terms of accounting standards and prescribed methods for booking and disclosing water “transactions” was broadly supported (Tello et al., 2016). While the Accountability Statement was broadly supported there was little consensus that GPWA collectively discharged the accountability of water managers. Taken collectively, these results suggest that GPWA may be more useful for improving management performance than accountability (Tello et al., 2016). The findings suggest that future iterations of the standard need to reconsider how accountability might be discharged through the production of GPWA. The broad support for GPWA suggests, however, that the financial accounting approach appears to be appropriate – and hence the accounting community may also make a valuable contribution to other areas of natural resource accounting (Tello et al., 2016).

The labelling of the water footprint of products in an Australian context was examined (Hazelton, 2014). The theoretical contribution and technical challenges of water labelling and in particular how water extractions might be evaluated and communicated were considered. It was observed that a water footprint reporting could make a significant contribution to public water literacy (Greiling & Grüb, 2015). However, significant technical hurdles remained, such as in appropriately distinguishing differing impacts of water extractions as well as in relation to measurement, allocation and information overload. This suggests that labelling of complex products is currently infeasible but existing and emerging solutions to these issues suggest that labelling of simpler products is a realistic possibility. Additionally, future research might focus on overcoming each of the challenges noted above for a particular product in order to bring water labelling closer to practical reality (Hazelton, 2014).

Since the Rio Earth Summit was held in 1992, freshwater has become an increasingly prominent issue in the global arena and attention has turned to the role of the corporate sector for water conservation measures. Various corporate water accounting standards currently exist on a voluntary basis (Tello et al., 2016). The accounting standards range from water-related components in sustainability standards to standards specifically focused on water and/or a particular industry (Hazelton, 2015). While academic research on the adoption of these standards is sparse, initial findings reveal generally poor water reporting in terms of both quality and quantity (Hazelton,

2015; Tello et al., 2016). In future, the major areas where reporting (and standards) could be improved are the provision of site-level water information and the assessment of water risk throughout the supply chain (Hazelton, 2015).

As presented earlier in this research literature on a research conducted by Egan (2014) in Austranian University, a focus on water usage accountability was motivated by acute water scarcity crisis encountered across large parts of Australia due to drought conditions between 1990s and the 2000s. Public policy responses emphasised water demand management strategies. The response to these challenges was examined within a large Australian university from 1999 to 2010.Egan's (2014) research demonstrates that measurement is essential to understanding patterns of water usage. The research implied that higher education continues to be an environment where creative responses to community challenges can be nurtured (Egan, 2014). Thus, despite increasing pressures to focus on financial outcomes, the sector should continue to nurture opportunities to shape issues of community concern through leading practice. Therefore, the insight to the development, fragility, and contested meaning of emergent systems of water accountability within the context of a university was revealed in the research (Egan, 2014) which has a direct bearing on this current research.

6.5 Voice and water provision

Voice, which is closely associated with accountability, captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media (Kaufmann et al., 2009). Some of the variables reflecting the voice include human rights, transparency of government policymaking, freedom of expression, access to information, trust in government, transparency of government policy among others (Kaufmann et al., 2009).

Government institutions need to have an effective and inclusive public administration at the national, regional and local levels in order to have a successful implementation of a national development agenda (Anderson et al., 2015). Research shows that citizens in democratic societies have a right to be informed about decisions on public policy and those they elect to enact such policy (O'Sullivan & O'Dwyer, 2015). Thus, citizens believe that they should be respected and dignified enough to participate in

this democratic form of governance and decision-making (O'Sullivan & O'Dwyer, 2015). Some of the variables reflecting the voice include human rights, transparency of government policymaking, freedom of expression, access to information, trust in government, transparency of governmental policy among others (Kaufmann et al., 2009). For instance, annual reports are usually reviewed by the public to assess the performance of authorities for the delivery of services. Such reports, however, are compiled differently depending on the context and the audience for which they are presented to. Corporate water disclosures may not necessarily be in the form of annual sustainability reports, however, but may include reporting by government agencies via public databases and product labelling (Hazelton, 2013). Therefore, access to corporate water-related disclosures may indeed constitute a human right.

Political participation is a founding human right, water is a critical subject of political debate, water-related information is required in order for political participation and the state is in a position to facilitate provision of such information (Hazelton, 2013). Thus, the government's fundamental functions, which include establishing a regime for protection of rights over citizens and property, promoting the general welfare, promoting social justice, cannot be accomplished without effective governance and public administration institutions and stakeholder engagement platforms which enable them to voice their opinions and concerns (Anderson et al., 2015). Hence, in the context of this research, the voice promotes accountability and water provision.

6.6 Conclusion

This chapter presented the literature review of the importance of financial accountability and water accountability for effective water provision. The review highlighted various factors that impact on accountability and water provision, notably, the concept of water as a basic human right. Furthermore, the obstacles of accountability, monitoring and approaches followed by various scholars for achieving effective accountability for water provision were discussed. Lastly, the impact of citizen voice on water provision was presented. The following chapter presents the literature focusing of the role of water infrastructure financing on sustainable development.

CHAPTER 7

THE ROLE OF WATER FINANCING ON SUSTAINABLE DEVELOPMENT

7.1 Introduction

Water is fundamental for life because it plays a vital role in social, economic and environmental development which are pillars of sustainable development (Griggs et al., 2013; Flörke et al., 2013; Kalbus et al., 2012). Sustainable development promotes the provision of water for all, as stipulated in goal 10 of the Millennium Development Goals (MDGs) (Pahl-Wostl et al., 2013a; Briggs et al., 2013; Sachs, 2012; Gleick & Ajami, 2014). However, water-related MDG targets were not fully realised by the end of 2015 due to weak water infrastructure funding and inefficient water governance (Bartram et al., 2014; Sachs, 2012; Bogardi et al., 2012). While this section discusses the importance of infrastructure financing for sustainable development, its main focus is to highlight the role of water provision in rural poverty alleviation.

7.2 The impact of the hydrological cycle and water availability on the economic development.

Although Africa experiences a lot of rainfall, however, rainfall patterns are highly seasonal and unevenly distributed across the Sub-Saharan Region (Kula et al., 2013; Ngoran et al., 2015). Such rainfall patterns destroy economic livelihoods and farmers' food sources, thus posing a significantly negative effect on the Gross Domestic Product's (GDP) growth in one-third of the Sub-Sahara African countries (Sage, 2014; Lal, 2013; Yaro, 2013; Moyo et al., 2012), hence the alternative to insufficient rainfall is an effective water infrastructure and water delivery to assist with the provision of water, not only for drinking and sanitation, but also for agricultural production (Gleick & Ajami, 2014; Cosgrove & Rijsberman, 2014; Ellis, 2013).

A well-developed water infrastructure plays a pivotal socio-economic role in poor communities as it promotes subsistence farming and production of cash crops, thus eradicating poverty and promoting food security (Baiphethi and Jacobs, 2009; Pahl-Wostl et al., 2013; Molden et al., 2014). However, given current water scarcity as well as lack of finance and water infrastructure in Africa (Gleick, 2014; Mehta, 2014; Reddy & Wallis, 2012), women and children in poor rural communities are compelled to travel

long distances to fetch water from local streams or wells (Ubuoh et al., 2014; Kehler, 2013; Van Houweling et al., 2012; Hilson, 2012).

7.3 Water infrastructure for socio-economic development

Water infrastructure has therefore been recognised as an indispensable element in human development and its absence in developing countries has had a prevalent effect on widespread poverty (Sen, 2006; Van Houweling et al., 2012; Hilson, 2012). A united effort in dismantling public sector obstacles to improved infrastructure would make a positive difference in poverty eradication and economic development (Sen, 2006:5; Gleick & Ajam, 2014; Kehler, 2013). Water infrastructure is seen as a fundamental vehicle to poverty alleviation. However, Sen (2006), Bain et al. (2014) and Koolwal & Van de Walle (2013) argue that the absence of water infrastructure and water provision might entrench poverty which cannot even be improved by personal income. In addition, poverty may not be alleviated by the devastating consequences of the absence of water infrastructure and water delivery. Consequently, an outbreak of waterborne diseases may be encountered by poor rural and vulnerable communities (Fogde & Carey, 2013; Cash et al., 2014). However, a developed water infrastructure with improved water provision would serve a developmental role in eradicating water borne diseases; alleviating the suffering of women and children who toil and trek long distances searching for water (World Bank, 1993; Ubuoh et al., 2014; Kehler, 2013; Hilson, 2012). It would also assist in providing food in rural communities (Cosgrove & Rijsberman, 2014; Rasul, 2014; Barthel & Isendahl, 2013).

Sustainability, in the sense of continued water delivery and uptake of services, is threatened by numerous attitudinal, institutional and economic factors, and the community participation approaches alone are no guarantee of success (Carter et al., 1999; Gleick & Ajami, 2014; Cosgrove & Rijsberman, 2014). The key to sustainable water provision is that all stakeholders involved in consumption of water, maintenance, cost recovery and continuing support for infrastructure, perceive it in their best interests to deliver high-quality water supply services (Carter et al., 1999; Flörke et al., 2013; Kalbus et al., 2012). In the face of the global challenge resulting from lack of water infrastructure and rainfall, researchers continue to explore alternative technologies used to ensure sustainable water supply in the presence of rainfall and infrastructure challenges affecting the socio-economic development of developing

communities (Flörke et al., 2013; Kalbus et al., 2012). These technologies include rainwater harvesting, groundwater exploration and management and water conservation.

7.4 Rainwater harvesting and water infrastructure development

The global water crisis is predicted to kill 34 to 76 million people by 2020 (Cain, 2014; Jury & Vaux, 2007). Although large-scale infrastructure projects can provide water, the construction of these projects proved to be inadequate for meeting water demands for growing populations, often resulting in significant social, economic and environmental impacts (Cain, 2014; Flörke et al., 2013; Kalbus et al., 2012). Scholars continue to prioritise efficient and sustainable, community-scale projects in addition to existing centralised infrastructure. Thus, small scale rainwater harvesting is one sustainable and increasingly effective means of providing water to rural and urban communities in developing countries (Cain, 2014; Gleick & Ajami, 2014; Cosgrove & Rijsberman, 2014).

According to Pacey & Cullins (1986), rainwater harvesting is defined as the gathering and storage of water running off surfaces on which rain has directly fallen, with the potential to serve as an alternative source of water in small communities that cannot be served by more centralised water supply schemes. Rainwater could be collected from rivers or roofs, then be redirected to a deep pit (well, shaft, or borehole), a reservoir with percolation, or collected from dew or fog with nets or other tools (Boers & Ben-Asher, 1982; Abdulla & Al-Shareef, 2009).

The harvested water is often used for gardening, livestock watering, irrigation, domestic use coupled with proper treatment. It can also be used for drinking, longer-term storage and for groundwater recharge (Pandey et al., 2003; Abdulla & Al-Shareef, 2009). The rainwater harvesting infrastructure is designed, organised and implemented in a manner that is suitable for use within the social, economic, technical and environmental dimensions of rural development (Pacey & Cullis, 1986; Pandey et al., 2003; Boers & Ben-Asher, 1982).

During regional water restrictions and drought periods, rainwater harvesting provides an independent water supply and it is often used to supplement the main supply in developed countries (Abdulla and Al-Shareef, 2009; Pandey et al., 2003). It can also help mitigate flooding of low-lying areas; and it reduces demand on wells which may

enable ground water levels to be sustained (Pacey and Cullis, 1986; Pandey et al., 2003). Therefore, rainwater harvesting provides a substantial benefit for both water supply and wastewater subsystems by reducing the need to augment bulk water infrastructure to provide clean water in the water distribution system. The harvested water helps to reduce the volume of storm water transferred into sewer systems; it also reduces the storm water runoff from polluting freshwater bodies in urban water systems (Abdulla and Al-Shareef, 2009; Pandey et al., 2003). In spite of the benefits of rainwater harvesting, most urban areas are faced with water scarcity, growing water demand and a limited conventional water supply. They seem to have neglected the benefits of rainwater harvesting (RWH) in their urban design and planning in the context of a sustainable management of water (Jones and Hunt, 2010; Abdulla and Al-Shareef, 2009). Therefore, urban planning should consider the environmentally friendly designs of RWH infrastructures while considering economic, social and technological factors (Angrill et al., 2012; Jones & Hunt, 2010; Pacey & Cullis, 1986). However, there is still a lack of knowledge regarding the most adequate scale in financial terms for RWH infrastructures particularly in dense areas such as the city of Granollers, Spain, which has a Mediterranean climate (average rainfall 650 mm/year) (Farreny et al., 2011; Jones & Hunt, 2010). In Granollers, for instance, rainwater harvesting strategies appear to be economically beneficial provided that it is implemented on the appropriate scale, enabling economies of scale and considering the expected evolution of water tariffs (Gill et al., 2007; Fareny et al., 2011; Angrill et al., 2012). It is therefore necessary to choose the appropriate scale for rainwater infrastructures in order to make rainwater harvesting economically feasible (Jones and Hunt, 2010; Fareny et al., 2011; Angrill et al., 2012; Morales-Pinzón et al., 2012).

Part of the effort to achieve the 7th Millennium Development Goals (MDG), was to reduce the proportion of people without sustainable access to safe drinking water and basic sanitation by half (World Bank Group, 2012). However, in developing countries such as South Africa, 20% of the population does not have access to adequate water supply and 33% lack proper sanitation services (Kahinda et al., 2007; Montgomery & Elimelech, 2007; Hunter et al., 2010). Therefore, in the light of inadequate water provision in developing countries, domestic rainwater harvesting provides water directly to households, thus enabling a number of small-scale productive socio-economic activities (Gill et al., 2007; Fareny et al., 2011; Angrill et al., 2012). Rainwater

harvesting also has the potential to supply domestic water even in rural and peri-urban areas that conventional technologies cannot supply (Magliano et al., 2015; Jones & Hunt, 2010; Fareny et al., 2011).

In the light of this opportunity, the South African government has committed itself to provide financial assistance to poor households for the capital cost of rainwater storage tanks and related works in the rural areas (Jaglin, 2002; Kahinda et al., 2007; Enninful, 2014). However, despite this financial assistance, the legal status of domestic rainwater harvesting remains unclear and domestic rainwater harvesting is in fact illegal by strict application of the water legislations (Morales-Pinzón et al., 2012; Enninful, 2014; Elgert et al., 2015). Beyond the cost of installation, maintenance and proper use of the domestic rainwater harvesting systems to ensure its sustainability, there is risk of waterborne diseases (Kahinda et al., 2007; Fogde & Carey, 2013; Cash et al., 2014). Incidences of disease linked to consumption and utilisation of harvested rainwater have been reported recently (Cash et al., 2014; De Kwaadsteniet et al., 2013; De Man et al., 2014; Dobrowsky et al., 2014). However, various methods are recommended by various scholars, for the disinfection and treatment of harvested rainwater and these include the use of filter systems, heat treatment, and chlorination, among others (Fogde & Carey, 2013; Naddeo et al., 2013; Dobrowsky et al., 2014; De Kwaadsteniet et al., 2013).

7.5 Water conservation as an alternative to infrastructure development

Many regions of the world are experiencing drought and water shortages (Sauri, 2014). Furthermore, there is ongoing evidence of climate variability and growing populations around the world which amplifies the need to adapt efficient water-use patterns (Kalu et al., 2014; Buhaug and Urdal, 2013). As a result, arid and semi-arid regions are compelled to improve their water resources management approaches by adopting economically attractive measures for water security (Ward, 2014; Salman et al., 2014; Tortajada & Joshi, 2013). Consequently, water conservation measures prove to be effective and popular mechanisms for reducing water demands at various scales throughout the world (Zellner, 2014; Cosgrove & Rijsberman, 2014; Gleick and Ajami, 2014).

Thus in recent years, severe drought in Southern Africa has compelled various water user sectors to appreciate the economic benefits of using water efficient technology in

their operations (Flörke et al., 2013; Willis et al., 2013; Schuetze & Santiago-Fandiño, 2013). For instance, the irrigation sector has adopted water efficient irrigating methods, crop mix, and alternative water sources in the face of water shortage (Ward, 2014; Elliott et al., 2015; Knox et al., 2012). In the face of limited surface water availability, farmers resort to groundwater extraction in spite of increased cost of pumping or reduces yield. As a result, on-farm drought adaptation measures result in water conversion through efficient irrigation technologies that are cost effective to convert to (Knox et al., 2012; Ward, 2014). For example, public subsidies to convert from flood to drip irrigation proved to offset the negative impacts of drought on farm income (Ward, 2014; Jobbins et al., 2015; Elliott et al., 2015). Thus subsidies could also raise the value of food production and reduce the amount of water applied to crops.

Water efficiency measures have been responsible for the reduction of domestic water consumption and have received much research attention in recent years (Sauri, 2014; March et al., 2013; Rost et al., 2015). However, research on the contribution of such water efficiency measures in reducing hourly water demand and subsequent benefits to urban water service infrastructure efficiency is still in its infancy (Carragher et al., 2012; Willis et al., 2013; Beal et al., 2013). Technology such as showerheads, dual flushing toilets, using buckets to wash cars, and water reuse for gardening, are some of the water use efficiency measures in the domestic sector which conserve water (Flörke et al., 2013; Willis et al., 2013; Schuetze & Santiago-Fandiño, 2013).

In water-stressed areas, water conservation measures prove to be the most economically viable water supply option available (Zellner, 2014; Teshome et al., 2013; Marinho et al., 2014). However, in arid regions such as Saudi Arabia, domestic water conservation awareness programmes are not implemented due to lack of awareness about the extent of the water scarcity problem. As a result there are only a few communities with water conservation tools installed in their houses (Sauri, 2014; March et al., 2013; Rost et al., 2015). On the contrary, in Barcelona, Spain, conservation campaigns proved to be successful in raising awareness about drought, however, the messages failed to target specific uses (March et al., 2013). Thus, there is a need for improved water conservation awareness campaign which would alleviate the demand for additional water infrastructure development (Ouda et al., 2013; Cosgrove & Rijsberman, 2014; Gleick & Ajami, 2014). Water conservation campaigns

alone are, however, not enough to ensure sustainable water conservation in communities experiencing water shortages.

Stakeholder engagement between public or private sectors and the society at large is imperative in order to ensure compliance and successful implementation of water conservation and demand management (Tortajada & Joshi, 2013; Ouda et al., 2013; Cosgrove & Rijsberman, 2014). For example, in Singapore, water conservation, public education, information and awareness instruments have enabled the public to appreciate the importance of conserving water against the cost of water infrastructure development (Tortajada & Joshi, 2013; March et al., 2013; Rost et al., 2015). Therefore, in the absence of sustainable water infrastructure development, developed and developing countries may consider developing policies aimed at reducing water consumption as well as in providing alternative supplies of water for both the domestic and the industrial sectors (Tortajada & Joshi, 2013; Flörke et al., 2013; Willis et al., 2013; Schuetze & Santiago-Fandiño, 2013).

7.6 Water quality and water infrastructure management

Many developing countries have urban areas that are expanding rapidly due to high urbanisation and population growth rates. Backlogs in developing urban water systems led to frequent interruptions in water supply, contaminated drinking water and poor sanitation facilities. Consequently, human health and the environment as a whole are threatened (Machdar et al., 2013; Cosgrove & Rijsberman, 2014; Alsan & Goldin, 2015).

There is consensus among researchers that a safe, reliable, affordable and easily accessible water supply is essential for good health, however, for several decades almost 1 billion people in developing countries have lacked access to such a supply (Hunter et al., 2010; Cosgrove & Rijsberman, 2014; Jeandron et al., 2015; Jeandron et al., 2015). Water distribution systems are vulnerable to performance deficiencies such as water outages, which can cause contamination of treated water and plausibly lead to increased risk of gastrointestinal illnesses (GII) in consumers (Starkl et al., 2013; Ercumen et al., 2014; Alsan & Goldin, 2015). Therefore, a poor water supply has a negative impact on human health by causing acute infections such as diarrhoea, resulting from chemicals such as arsenic and fluoride in water (Dangour et al., 2013; Alsan & Goldin, 2015). Given the health burden on the public and the costs to the

health system, health professionals are also encouraged to join with others in demanding accelerated progress towards global access to safe water.

In developing countries in a city such as Accra, Ghana, the majority of inhabitants live in over-crowded areas with limited access to a piped water supply, which is often also intermittent (Machdar et al., 2013). Therefore, with the absence of efficient water treatment systems and sustainable supply of potable water, cost effective interventions are useful for such communities. Thus, water from household storage, private yard taps, communal taps, communal wells and water sachets are responsible for reducing the prevalence of water borne diseases (Ercumen et al., 2014; Alsan & Goldin, 2015).

The disinfection of water at household level is the most cost-effective intervention together with hygiene education (Machdar et al., 2013). Guangzhou in China also encounters poor groundwater quality problems due to the development of the city (Strohschön et al., 2013). Informal building expansion, unsustainable use of groundwater, as well as high concentrations of coliform bacteria in urban rivers, resulted from insufficiency in city planning and poor water supply and sanitation, resulting in wide range of ecological and social vulnerabilities (Strohschön et al., 2013).

Cholera remains a significant threat to global public health with an estimated 100 000 deaths per year (Kahn et al., 2013; Taylor et al., 2015; Jeandron et al., 2015). Cholera outbreaks usually occur in places with poor sanitation and poor access to clean surface and ground water, such as slums and refugee camps in developing countries. Consequently, people get cholera by drinking water or eating foods contaminated by the faecal coliform bacteria of infected individuals (Kahn et al., 2013; Schmoll et al., 2013; Jeandron et al., 2015). Therefore, based on the research conducted in the Democratic Republic of the Congo, an association between reduced availability of tap water and increased incidence of suspected cholera in an urban area was observed (Jeandron et al., 2015; Machdar et al., 2013; Bain et al., 2014). Thus, improving the reliability of the water supply could substantially reduce the incidence of cholera, particularly in neighbourhoods with greater access to tap water. Although infrastructure financing is available, without the appropriate technical skills for proper water treatment, reliability of the water supply is not possible and it could compromise

public-health by supplying poor quality tap water to users (Khan et al., 2013; Bain et al., 2014; Jeandron et al., 2015).

Waterborne infections such as the cholera outbreaks could also occur during emergencies, such as earthquakes and flood events, or in refugee settings when water supply, sanitation and hygiene (WASH) infrastructure is compromised (Taylor et al., 2015; Dijk et al., 2013; Dangour et al., 2013). Thus, when an outbreak is detected a response focusing on reducing mortality is recommended because natural disasters could disrupt sanitation and water systems which can also trigger cholera outbreaks (Kahn et al., 2013; Taylor et al., 2015; McFeters, 2013). The objective is to ensure a prompt response towards the affected communities by reducing morbidity by providing safe water, adequate sanitation and health promotion (for improved hygiene and safe food handling practices) (Taylor et al., 2015; Khan et al., 2013; Taylor et al., 2015). As a result, the cholera epidemics require the same interventions used to prevent and control diarrhoeal diseases. In order to reduce the health risk from water-borne infections, it is necessary to immediately stop the uses of drinking water from contaminated sources (Brown et al., 2013; Dash et al., 2013; McFeters et al., 2013). Consequently, local authorities are required to supply alternative sources of water such as: trucking of chlorinated water, chlorinating individual water containers, or distribution of products for household water treatment (Bain et al., 2014; Khan et al., 2013; McFeters, 2013). In the interest of containing the spread of the outbreak, multiple interventions may be implemented at the same time. These interventions may include: community education about home based water treatment, the promotion of personal and food hygiene as well as promotion of household disinfection and hygiene kit distribution, all of which depend on the respondent's resources and capacity (Taylor et al., 2015; Dangour et al., 2013; Freeman et al., 2014).

Although the research conducted by Sen (2006), Gleick and Ajam (2014), Kehler (2013), Moyo et al., (2012) and Fogde and Carey (2013) focused on water provision that is important for the alleviation of poverty and for food security for rural communities in sub-Saharan Africa, their research, however, does not address other important drivers of sustainable water provision such as adequate financial investment, financial governance and financial accountability by local authorities, in the context of South Africa. Thus, this a gap is what this research intends to bridge.

7.7 Effects of water availability on rural women and children

Seventy-five percent (75%) of the world's poor live in rural areas (Peredo & Chrisman, 2006; Vu & Glewwe, 2011). Global rural poverty rates have declined from 37 to 29 percent between 1993 and 2002, mainly due to the achievements in East Asia, where poverty rates declined from 35 to 20 percent in ten years (Eslamian & Arif, 2011). In contrast, rural poverty remains high in South Asia (39 percent in 2002), where the highest concentration of rural poor is found (400 million) and sub-Saharan Africa where the poverty rate has hovered above 50 percent for the last ten years (World Bank, 2008). Most of the rural poor depend on agriculture which is a source of livelihoods for an estimated 86 percent of rural population (2.5 billion people) and it provides jobs for 1.3 billion smallholders and landless workers (World Bank, 2008). Therefore, a more dynamic and inclusive agricultural sector proved to dramatically reduce rural poverty, thus helping countries meet the Millennium Development Goal of halving poverty and hunger by 2015 (World Bank, 2008). Therefore, agricultural growth is especially effective in reducing poverty.

This according to the cross-country econometric estimates which show that overall GDP growth originating in agriculture is at least twice as effective in benefiting the poorest half of a country's population as growth generated in non-agricultural sectors (Awuah, 2013; Christiaensen et al., 2011). Indeed, many countries that had relatively high agricultural growth rates saw substantial reductions in poverty. For instance, China's rapid growth in agriculture, thanks to the household responsibility system, the liberalisation of markets, and rapid technological change, was initially responsible for the rapid decline in rural poverty from 53 % in 1981 to 8 % in 2001. Agriculture was also the key to India's slower but still substantial long-term decline of poverty. Most recently, Ghana is Africa's breaking story of a 24-percentage point reduction in rural poverty over 15 years, in part because of a recent strong agricultural performance (Dercon, 2009).

Agricultural growth can reduce poverty directly, by raising farm incomes and indirectly through labour markets and by reducing food prices. The poverty-reducing effect of increasing farm incomes depends on the participation of poor smallholders in the

growth process. Agricultural growth also reduces poverty to the extent that it creates employment opportunities for the poor. For example, in South Asia and Latin America, 25% of the active rural males, usually the poorest, are primarily employed as wage labourers in the agricultural sector. Increasing productivity of those staple foods that are non-tradable reduces food prices to poor consumers. In addition, more than half of poor rural households are typically net food buyers benefiting from lower prices. Researches from India show that, in the long term, the food price effect has the largest influence on poverty reduction. Therefore, a policy environment conducive to faster agricultural growth is necessary for poverty reduction. However, in order for agricultural growth to reduce poverty substantially, smallholder farming must be competitive and sustainable. The poverty-reducing effects of growth also depend on a buoyant rural non-farming economy, often linked to agriculture. Furthermore, access to land, water and human capital critically determine the ability of households to participate in agricultural markets, secure livelihoods in subsistence farming, compete as entrepreneurs in the rural non-farming economy, and finding employment in skilled occupations (Baiphethi & Jacobs, 2009; Molden et al., 2014; Mehta, 2014).

Currently, more than two-thirds of the population in Africa must leave their homes to fetch water for drinking and domestic use (Pickering and Davis, 2012). Poor rural women in the developing world spend a considerable time collecting water. The time burden of water fetching has been identified as one of the factors that influences the volume of water collected by households, the time spent on income generating activities and child care (Koolwal & Van de Walle, 2013; Pickering & Davis, 2012). The Demographic and Health Surveys, carried out in 26 countries in Africa, were used to assess the relationship between walking time spent by households to fetch water from the local source with the child health outcomes (Pickering & Davis, 2012; Rosen & Vincent, 2001). Women living in places where more time is needed for water collection tend to participate less in income-earning market-based activities (Koolwal & Van de Walle, 2013). In addition, education outcomes of their children tend to be worse as they also participate in water collection from sources far from home. Thus depriving them from the time required to obtain education (Koolwal & Van de Walle, 2013).
For instance, South Africa's rivers are prone to microbial pollution. This is due to a large number of informal settlements located near river systems lacking adequate sanitation (Gemmell & Schmidt, 2010). As part of subsistence farming, fresh

vegetables are often irrigated with this contaminated water. Laboratory analyses of fresh vegetables harvested from such irrigation were conducted. Findings confirmed that the transfer of river bound microorganisms via irrigation water to fresh produce could take place, leading to fresh produce contamination at unacceptable levels of pathogens (Gemmell & Schmidt, 2010). Therefore, the time spent walking to a household's main water source was found to be a significant determinant of under five year old child health (Pickering & Davis, 2012). The health costs of rural water supplies, encompasses the burden of water-related diseases, the productivity costs of these diseases, and the impact of water supply interventions in Africa. (Rosen & Vincent, 2001; Pickering & Davis, 2012). Furthermore, there are countries where substantial gender gaps in schooling and enrollments occur. Hence, better access to water was found to be associated with less unpaid work for women and more time for children to obtain education (Koolwal & Van de Walle, 2013; Rosen and Vincent, 2001). This suggests that reducing the time cost of fetching water could be a priority for water infrastructure investments in Africa (Pickering & Davis, 2012).

7.8 Climate change impact on water availability for subsistence farming

Recently, the effect of climate change has resulted in extreme weather conditions such as droughts and floods. Consequently, farming practices have changed in order to adopt to changes in weather patterns. Arid regions have recently encountered droughts resulting in water scarcity. These arid regions would often encounter short, intense and unevenly distributed flood events which are harmful to farming and food production.

7.8.1 Climate change impact on water availability for subsistence farming

The agricultural sector accounts for approximately 63% of total annual water utilisation worldwide, with 90% of water use attributable to agriculture and irrigation which is crucial for agricultural production, food security and poverty alleviation (Jara-Rojas et al., 2012). However, recently, climate change and the associated uncertainty have raised concerns regarding the future water scarcity globally and locally (Jara-Rojas et al., 2012). With climate change, it is predicted that rainfall in South Africa will become more uncertain and variable in the future, exposing more people to water insecurity (Quinn et al., 2011). Rain fed subsistence farming systems in sub-Saharan Africa generally produces low crop yields as a result of highly unpredictable rainfall seasons

(Makurira et al., 2011). This is particularly common in the Makanya Catchment, Tanzania, with a rainfall of less than 600 mm/annum where the spread over two agricultural seasons per year is clearly insufficient to support staple food crops in the area (Makurira et al., 2011).

Marginal or smallholder farmers and landless households consist of socially disadvantaged communities and families with very low incomes. As a result, a community oriented framework is required in order for the management of land, water and forest resources to be planned and implemented in developing the region, thus generating a viable means of off-farm employment at the local level (De Janvry & Sadoulet, 2011). South Africa has approximately 1.3 million households who are active in various supplementary food production activities on up to 3.3 million ha of rain-fed and irrigated agricultural land (Backeberg & Sanewe, 2010). This means, for 83% of households the size of the plot of land varies between 0.5 ha and 1 ha. Thus, smallholder farmers in poorer countries, such as India, Peru, and Guatemala subsistence farming are part of policy responses to water shortages and other distress of a food crisis in both the short and medium term (De Janvry & Sadoulet, 2011; Baipheti & Jacobs, 2009).

Limited rainfall with the adoption of water use efficiency techniques within the irrigation field are attributable for improved grain yields in Tanzania (Makurira et al., 2011). The re-allocation of limited water within the irrigation field serves as a mitigation measure against the impact of drought resulting from climate change, thus it allows for crop rotation during the rainfall seasons (Makurira et al., 2011). Lack of water availability and low agricultural productivity have resulted in large food deficits, leading to many of the adult male population migrating to other regions in pursuit of employment and better livelihoods (De Janvry & Sadoulet, 2011). Thus, in South Africa for instance, households depend on multiple sources of income, where rain-fed and irrigated farming contributes 10 to 30% to rural livelihoods (Backeberg & Sanewe, 2010). Priority is, therefore, given to productive water use for homestead food gardening and revitalisation of smallholder irrigation schemes (Backeberg & Sanewe, 2010).

Efficient management of water at the farm level is critical to the future sustainability of worldwide and regional agriculture. Climate change adaptation should therefore not be viewed in isolation but instead, in the context of social, economic and political

conditions, all of which shape local community vulnerability and people's ability to cope with it and adapt to climate change (Quinn et al., 2011). Therefore, farmers' perceptions of climate risk and their approaches to adaptation are influenced by socio-economic and political factors (Gandure et al., 2013). However, lack of interest in farming among the youth, the inherent imbalances in land access due to political history, government policies on free water access as well as social grants have created dependency and discouraged the need for adaptation to climate change (Gandure et al., 2013). Farmers deliberately adapting to climate change are innovative and independent of state support. Thus, rainwater harvesting, soil cultivation and crop production have an impact on dietary needs and it improves food security of poor households in South Africa (De Janvry & Sadoulet, 2011; Backeberg & Sanewe, 2010). Government policies must therefore be informed and guided by the risks and opportunities faced by farmers. Furthermore, farmers need to make conscious decisions to adapt to climate change based on their analysis of livelihood risks (Gandure et al., 2013).

7.8.2 Water for food production and poverty alleviation

Research estimates that by 2050 the global population increase will reach 9 billion, most of these in developing countries (Population Reference Bureau, 2016). In order to feed the world in 2050 and beyond, agricultural food production and mobilising 20 percent more fresh water needs to be strengthened globally in order to meet the required demand (Food and Agricultural Organisation, 2016). Feeding over 9 billion people by the second half of this century will require a major paradigm shift in agricultural systems since agriculture uses approximately 40% of the terrestrial surface, is the major user of fresh water resources and contributes 17% of greenhouse gas emissions (Chartres & Noble, 2015). The water footprint of agriculture is hundred times more than the footprint for domestic water use, yet the amount of water used in relation to the amount of food being produced is not known (Bastiaanssen et al., 2014).

Food security and water scarcity have become two major concerns for future of human sustainable development, particularly in the context of climate change (Liu et al., 2013). Meeting the food security and sustainability challenges of the coming decades is possible, but will require considerable changes in nutrient and water management (Mueller et al., 2012). Land development and water availability are required for food

production which largely depends on rate of yield gain of major cereal crops (Grassini et al., 2013). Many researches indicate that a warming climate has a negative effect on crop production and generally reduces yields of staple cereals such as wheat, rice, and maize, which, however, differ between regions and latitudes (Roudier et al., 2011; Sultan et al., 2013).

Although research on the impact of climate change on the production and water use of major cereal crops revealed that irrigation dependence in crop production is projected to increase on a global scale, however, several water scarce regions will depend less heavily on irrigation, which is conducive to alleviating regional water scarcity (Liu et al., 2013). In Africa, for instance, the continuous increase in temperature will lead to losses of crop production in the 2090s (Liu et al., 2013). Agricultural water use includes a purely rain fed to fully irrigated systems. Drought is a major driver of food insecurity and contributes to a negative impact on nutrition. Floods and tropical storms also affect food security by destroying livelihood assets (Porter et al., 2014). There is evidence of yield plateaux or abrupt decreases in rate of yield gain, including rice in eastern Asia and wheat in northwest Europe, which account for 31% of total global rice, wheat and maize production (Grassini et al., 2013).

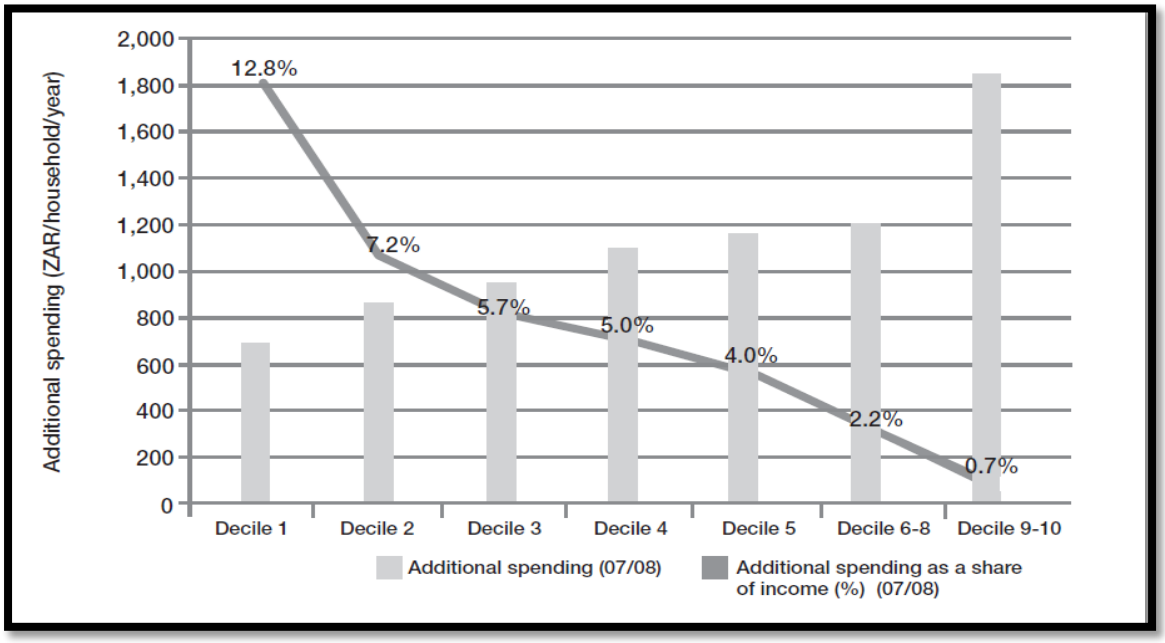
Since the Sustainable Development Goal two is enshrined in the 2030 Agenda for Sustainable Development, it remains a top development priority and global concern (Conceição et al., 2016). Thus water availability for agriculture is fundamental to improving food security and reducing poverty in arid and semi-arid developing countries in Africa (Liu et al., 2013; Conceição et al., 2016). Sub-Saharan Africa for instance, faces twin challenges of water stress and food insecurity that are already pressing and are projected to grow. Thus, the region comprises of a 43% arid and semi-arid area, which is projected to increase due to climate change (Hadebe et al., 2017). Growing demands on limited water supplies from domestic, industrial and environmental uses may continue, leading to a decline in water availability for food production. As a result, semi-arid and arid countries continue to increase net imports of food (Ringler & Zhu, 2015).

Although on a small-scale, rain fed agriculture is the main source of livelihood in arid and semi-arid areas of the region, however, sub-Saharan Africa continues to be affected by poverty and food and nutrition insecurity at national and household levels

(Mabhaudhi et al., 2016). Because rain fed agriculture constitutes more than 95% of agricultural land use, in the light of drought, water scarcity proves to be a major limitation to food production (Hadebe et al., 2017). For example, Lesotho has been faced with the food crisis as a result of a number of interlinking issues including periodic droughts which have led to crop failures, excessive soil erosion, declining rangeland conditions and chronic poverty (Leduka et al., 2015). Thus, persistent food insecurity in Lesotho continues to be a prolonged problem and a key obstacle in the country's development agenda (Leduka et al., 2015).

Between 2007 and 2009, South Africa experienced drought which led to increased food prices for maize and grains to meat, poultry and dairy products, thus unjustifiably impacting on the poor communities (Kirsten, 2012; Baiphethi & Jacobs, 2009). Although, in the past rural households produced most of their own food through subsistence farming, recent researches have shown an increase in dependence on market purchases by both urban and rural households, in some cases reaching 90% of the food supplies (Baiphethi & Jacobs, 2009). Consequently, food expenditure accounts for as much as 60% to 80% of total household income for low-income households in some parts of sub-Saharan Africa and the poorest households had to spend 13% more of their income (Baiphethi & Jacobs, 2009; Kirsten, 2012). Thus, according to Figure 1, food expenditure in South Africa has proportionally declined with increased income to only 0.7% more of their income for those in the highest income group (Kirsten, 2012; Leduka et al., 2015).

Figure 7.1: The impact of food price Inflation by Income in South Africa, 2007/8 –2008/9.



Source: Adopted from the Leduka et al. (2015) report, in Kirsten (2012).

Similarly, Australia which exports food products has been confronted with a severe drought in 2000-2009, which led to the reduction of dryland farming, reduced volume of water allocated for agricultural irrigation, as well as the decline in aggregate agricultural production and exports (Qureshi et al., 2013). Thus, Australia's contribution to international trade in wheat, meat and dairy products was reduced substantially, affecting global food prices (Qureshi et al., 2013).

Cereals which include sorghum, millet, wheat, maize and rice are major staple foods of the most population (Macauley & Ramadjita, 2015; FAOSTAT, 2012; Grain SA, 2015). Based on the findings of this research, there is an agreement with the indication by many researchers, that a warming climate has a negative effect on crop production and that it generally reduces yields of staple cereals such as wheat, rice, and maize, which, however, differ between regions and latitudes (Porter et al., 2014; Sultan et al., 2013; Roudier et al., 2011). As a result food security and water scarcity have become two major concerns for future human sustainable development, particularly in the

context of climate change (Liu et al., 2013; Bastiaanssen et al., 2014; Chartres & Noble, 2015).

Research on the impact of climate change on the production and water use of major cereal crops revealed that irrigation dependence on crop production is projected to increase on a global scale. As a result, a number of water scarce regions will have to depend less heavily on irrigation, which is conducive to alleviating regional water scarcity (Grassini et al., 2013; Liu et al., 2013; Conceição et al., 2016). In Africa, for instance, the continuous increase in temperature will lead to losses of crop production in the 2090s (Hadebe et al., 2017; Leduka et al., 2015; Liu et al., 2013). Although agricultural water use includes purely rain-fed to fully irrigated systems, drought seems to be a major driver of food insecurity and it has a negative impact on nutrition (Leduka et al., 2015; Mabhaudhi et al., 2016; Hadebe et al., 2017). There is evidence of yield plateaux or abrupt decreases in rate of yield gain, including rice in eastern Asia and wheat in northwest Europe, which account for 31% of total global rice, wheat and maize production (Grassini et al., 2013).

Unreliable rainfall received in many parts of the sub-Saharan Africa has reduced cereal production especially maize and wheat, and made farmers to shift to drought tolerant crops (Kaoneka et al., 2016). For example, recent drought faced by South Africa has severely affected the country's 2014-2015 harvest, especially summer crops such as maize (both white and yellow varieties) sunflower, soya beans, groundnuts, sorghum and dry beans (Grain SA, 2015). There was a prediction of a 29% decrease in summer crop production from the previous year due to drought (Grain SA, 2015). Consequently, for maize, which forms a staple food (e.g. mealie-meal), the picture is even worse particularly for the poor communities. As a result, as early as April 2015, consumer price inflation for items such as bread and cereals increased by 4.8% year on year, suggesting that consumers could expect further increases in inflation (Grain SA, 2015). Thus both examples suggest that agriculture is the engine for socio-economic growth in Africa and that water is fundamental to agriculture-based rural livelihoods, however, inadequate availability of water and unreliable access to the resource presents a common constraint to sustainable agricultural production and other related activities (Food and Agricultural Organisation, 2016).

Although small-scale, rain fed agriculture is the main source of livelihood in arid and semi-arid areas of the region, sub-Saharan Africa continues to be affected by poverty and food and nutrition insecurity at national and household levels (Mabhaudhi et al., 2016). Because rain fed agriculture constitutes more than 95 % of agricultural land use, in the light of drought, water scarcity proves to be a major limitation to food production (Hadebe et al., 2017). For example, Lesotho has been faced with a food crisis as a result of a number of interlinking issues including periodic droughts which have led to crop failures, excessive soil erosion, declining rangeland conditions and chronic poverty (Leduka et al., 2015). Thus, persistent food insecurity in Lesotho continues to be a prolonged problem and a key obstacle in the country's development agenda (Leduka et al., 2015).

Although in the past, rural households produced most of their own food through subsistence farming, recent researches have shown an increase in dependence on market purchases by both urban and rural households, in some cases reaching 90% of the food supplies (Baiphethi & Jacobs, 2009). Consequently, food expenditure accounts for as much as 60% to 80% of total household income for low-income households in some parts of sub-Saharan Africa and the poorest households had to spend 13% more of their income (Baiphethi & Jacobs, 2009; Kirsten, 2012). Thus, food expenditure in South Africa has proportionally declined with increased income to only 0.7% more of their income for those in the highest income group (Kirsten, 2012; Leduka et al., 2015). Similarly, Australia which exports food products, has been confronted with a severe drought in 2000-2009, which lead to the reduction of dryland farming, reduced volume of water allocated for agricultural irrigation, as well as the decline in aggregate agricultural production and exports (Qureshi et al., 2013). Thus Australia's contribution to international trade in wheat, meat and dairy products was reduced substantially, affecting global food prices (Qureshi et al., 2013).

Unreliable rainfall received in many parts of the sub-Saharan Africa has reduced cereal production especially maize and wheat, and made farmers to shift to drought tolerant crops (Kaoneka et al., 2016). For example, recent drought faced by South Africa has severely affected the country's 2014 to 2015 harvest, especially summer crops such as maize (both white and yellow varieties) sunflowers, soya beans, groundnuts, sorghum and dry beans (Grain SA, 2015). There was a prediction of a 29% decrease in summer crops production from the previous year due to drought

(Grain SA, 2015). Consequently, for maize which forms a staple food (e.g. mealie-meal), the picture is even worse particularly for the poor communities. As a result, as early as April 2015, consumer price inflation for items such as bread and cereals increased by 4.8% year on year, which suggested that consumers could expect further increases in inflation (Grain SA, 2015). The picture of increased inflation prospects is gloomy for the poor who cannot afford increased food prices. For many developing countries, increasing direct taxes is the most successful option when creating a more progressive tax structure while generating a positive impact on GDP (Kearney & van Heerden, 2015). However, for the poor rural communities who cannot afford inflated food costs due to poverty and unemployment, the Value Added Tax (VAT) presents a financial burden. Thus, Section 11 of the South African Value-Added Tax Act no 89 of 1991 provides for the supply of certain so-called basic foodstuffs to be zero-rated, which improves the welfare of poor households (Kearney & van Heerden, 2015).

Zero-rated food supplies are supplies you charge output tax of 0% on, which means you can claim input tax for your business and any tax invoices you issue must show VAT at the zero rate (Alderman & Del Ninno, C., 1999; Jansen et al., 2013; Kearney & van Heerden, 2015). The motivation behind zero rating is to provide basic foodstuffs at a reduced price in order to benefit the poor, thus alleviating poverty of poor households who spend the largest proportion of their income on food (Odhiambo & Odada, 2010; Jansen et al., 2013; Kearney & van Heerden, 2015). For instance, maize, which one of the staple foods for many poor communities in Africa, is currently exempted from VAT and it proved to be the best choice zero-rating from both the standpoints of equity and the impact on the food consumption of the poor (Alderman & Del Ninno, 1999; Odhiambo & Odada, 2010). Thus, zero-rating food combined with a proportional percentage can improve the livelihoods of poor households.

Thus a majority of smallholder farmers in Africa practice subsistence agriculture, however, due to low crop yields, poor soils, and lack of water are, among others, constraints that add to the difficulties for sustainable farming and incomes (Macauley & Ramadjita, 2015). Sorghum, millet, wheat, maize and rice constitute major staple foods of most of the African population, and these cereals are grown over an area of 98.6 million hectares producing 162 million tonnes (Table 1) (Macauley & Ramadjita, 2015; FAOSTAT, 2012; Grain SA).

Table 7.1: Area and production of selected cereal crops in South Africa.

Crop	South Africa (2012)	
	Area (ha)	**Production (ton)**
Maize	34,075,972	70,076,591
Millet	19,998,008	16,008,838
Rice, paddy	11,206,813	28,798,202
Sorghum	23,142,595	23,350,064
Wheat	10,224,952	24,704,201
Total	**98,226,080**	**162,422,507**

Source: FAO Statistics Division, 2012. Adapted from Macauley and Ramadjita, 2015.

There is a need to significantly increase the productivity of subsistence agriculture and water availability in order to ensure long-term food security. In the presence of water, subsistence agriculture can play an important role in reducing the vulnerability of rural and urban food-insecure households, improving livelihoods and helping to mitigate high food price inflation (Baiphethi & Jacobs, 2009). Over 200 million people were lifted out of rural poverty in China as per capita grain availability in the 1980s, which was phenomenal compared to those in developed countries (Oi, 2015). The Massive Food Production Programme (MFPP) aimed to reduce poverty by raising maize yields and availing water, was initiated in the Eastern Cape, South Africa (Fischer & Hajdu, 2015). Through MFPP, raising maize crop productivity proved to be most important for the poorest households who depended on it for their food security and poverty reduction (Fischer & Hajdu, 2015). Therefore, socio-economic development in developing communities means that the water demand will continue growing (De Fraiture et al., 2014). Furthermore, agricultural, domestic, energy and other water user sectors will continue to compete for limited water resources in the face of drought in arid and semi-arid countries (De Fraiture et al., 2014). Thus, the interconnectivity between sectors, water, food, energy and climate conditions therefore calls for new, integrated approaches to agricultural water management (Chartres & Noble, 2015; De Fraiture et al., 2014).

Researchers argue that looking at water for food production in isolation would miss important developments outside the water sector that determine the sustainability of agricultural water management (De Fraiture et al., 2014). Integrated approaches to food production are necessary to ensure sustainability (De Fraiture et al., 2014). This implies breaking disciplinary boundaries and encouraging greater cooperation from planning to implementation (De Fraiture et al., 2014). It is likely that the role of agricultural water management in ensuring food security will become more important (De Fraiture et al., 2014). Thus, sustainable intensification of agricultural techniques such as water management practices are necessary to promote higher agricultural production in a sustainable manner while improving resilience to drought and dry spells (Dile et al., 2013; Food and Agricultural Organisation, 2016).

7.8.3 Intervention to water shortage challenges

A long-lasting effort is needed for the world to increase resilience to climate change and reduce the risks of future food and water security (Liu et al., 2013). There is therefore a need for a paradigm shift in order to effectively deliver on the twin challenges of food and nutrition security under conditions of water scarcity (Mabhaudhi et al., 2016). Intervention needs to be prioritised in poor rural communities for poverty alleviation, socio-economic development, and for satisfying growing food demands in a rapidly urbanising world (Dile et al., 2013). In the face of drought resulting from climate change, adaptation along with sustainable agriculture production is necessary to maintain the agricultural production and enhance global food security (Qureshi et al., 2013; FAO, 2016).

Poverty alleviation should be a top priority for socio-economic development of poor rural communities, particularly against a background of the predicted population increase, growing food demands, rapidly urbanisation and increased food prices (Dile et al., 2013). Similarly, in subsistence farming, improving food security and alleviating rural poverty require guidance and technical support to enhance the quality, impact and sustainability of agricultural water management investments (De Janvry & Sadoulet, 2011; Beddington et al., 2012; Sinyolo et al., 2014). It is therefore important to consider the diversity and complexity of the country contexts and to tailor interventions to rural population priorities and livelihood strategies in order to compensate for water shortages resulting from drought (Food and Agricultural

Organisation, 2016; Beddington et al., 2012; Smith & Gregory, 2013). Furthermore, sustainable intensification of agricultural techniques, such as water management practices resulting in higher agricultural production without causing severe environmental impacts, are therefore required in order to improve resilience to drought and dry spells (Dile et al., 2013; Smith & Gregory, 2013). One of the initiatives followed by many drought stricken countries is the production of drought resistant cereal crops such as millet and sorghum.

Millet and sorghum are hardy dryland staple cereals. Millet is the most inherently drought-tolerant of all the major staples in Africa and Asia, and together with sorghum, they are key cereal grain crops in the drylands, providing food, feed and, in the case of millet, fuel and construction material as well (Patil, 2016; Nagaraj et al., 2013; Gilding et al., 2013; Hadebe et al., 2017). Despite formidable obstacles to improvement of these crops for drylands, plant breeders at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and national partner organisations have made important gains and farmers are adopting new varieties (Shiferaw et al., 2014). Sorghum is central to addressing the challenges of securing a food supply in Africa and in Southern Africa, for example, about 34 percent of the total millet area is now planted with improved materials and 23 percent of the sorghum area (Hadebe et al., 2017; Shiferaw et al., 2014). As a drought-adapted cereal capable of reliable production where other cereals fail, sorghum is a good candidate for addressing food security as agricultural inputs of water and arable land grow scarce (Gilding et al., 2013; Hadebe et al., 2017). Aside from being a crop that is well adapted to address food insecurity, sorghum has gathered attention as a biofuel and feedstock with water efficiency advantages over maize (Gilding et al., 2013; Mueen Alam, 2013; Hadebe et al., 2017).

7.8.3.1 Policy reform for water provision and food production

Drought resulting from climate change is one of the extreme weather events thought to increase the risk of violent civil conflict, especially in areas that are prone to severe food shortages in some developing communities (Alix-Garcia et al., 2012; Bell et al., 2013; Pandey et al., 2014). Global climate is predicted to increase the frequency of such scarcity-inducing events in sub-Saharan Africa (Pandey et al., 2014; Bell et al., 2014; Turpie & Visser, 2013). Food policies play a fundamental role towards achieving

successful stability in African communities during drought periods (Bell et al., 2014; Alix-Garcia et al., 2012). Policies that give effect and regulate domestic food production and those that increase reliance on imported foreign- grown food need to be reviewed in order to adapt to prevalent drought conditions (Shiferaw et al., 2014; Dupraz & Postolle, 2013; Crump, 2010). Thus the success of these policies depends largely on the state's capacity to adapt to environmental dynamics and local context.

Where such capabilities are successful, states should ensure equitable distribution and allocation of the secured food in order to reduce the conflict over limited food resources during drought conditions (Bell et al., 2013; Turpie & Visser, 2013). In areas where the distribution of imported food is limited by corrupt leadership and citizens, an alternative means to boost domestic food production substantially is necessary (Bell et al., 2014; Shiferaw et al., 2014; Dupraz & Postolle, 2013). In that way, the risk of drought-induced conflict is avoided.

7.8.3.2 Zero-rating of food

Increasing direct taxes is the most successful option when creating a more progressive tax structure, and still generating a positive impact on the GDP (Kearney & Van Heerden, 2015). However, for the poor who cannot afford it due to poverty and unemployment, the VAT presents a financial burden. As a result, Section 11 of the South African Value-Added Tax Act no 89 of 1991 provides for the supply of certain so-called basic foodstuffs to be zero rated which improves the welfare of poor households (Kearney & Van Heerden, 2015). Zero-rated food supplies are supplies you charge output tax of 0% on, which means you can claim input tax for your business and any tax invoices you issue must show Vat at the zero rate (Alderman & Del Ninno, 1999; Jansen et al., 2013; Kearney & Van Heerden, 2015). However, the zero-rating of value added tax (VAT) cannot be applied liberally, especially when it comes to certain food products. Only a select few food items qualify as zero-rated food supplies and these include brown bread, dried mealies, dried beans, lentils, pilchards or sardinella in tins or cans, rice, fresh fruit and vegetables, vegetable oil, milk, eggs and edible legumes (SA VAT Act 89 of 1991). However, the zero rating is not available where the goods are provided as a meal, ready for consumption when supplied. For instance, where a carton of milk is bought over the counter, the supply will be zero rated, but if bought as part of a meal, the supply becomes standard rated. Therefore, zero-rating food is considered to alleviate poverty of poor households who spend the largest proportion of their

income on food (Odhiambo & Odada, 2010; Jansen et al., 2013; Kearney & Van Heerden, 2015). Maize is an example of astaple food for many African communities which is currently exempted from VAT and it a zero-rated (Alderman & Del Ninno, 1999; Odhiambo & Odada, 2010). Thus, zero-rating food combined with a proportional percentage could improve the livelihoods of poor households.

7.8.3.3 International trade of virtual water

The effect of climate change has led to increased temporal and spatial variability of precipitation in Southern Africa (Dalin & Conway, 2016; Dube et al., 2016; Garnett et al., 2013). As a result, the associated drought and flood risks which present a challenge on rain-fed agriculture, have a negative impact on water availability for food security in the region (Garnett et al., 2013; Dalin & Conway, 2016). A comparative appraisal of the impacts of climate change on agro-ecological based livelihoods and development in developing countries across the African continent, focusing on Eastern, Western, Southern Africa and the Sahel region was done by Dube et al. (2016a). The impact of climate change was found to be invariably negative across the whole of Africa, resulting in reduced agricultural yields and a decline in bio-diversity (Dube et al., 2016b; Garnett et al., 2013). Hence, an intensification for the support of livelihood diversification strategies in rural development planning is sought (Hussein & Nelson, 2016). Furthermore, the reform of policy strategies that target the poor and vulnerable communities whose livelihoods depend on agriculture and natural ecosystems impacted by climate change, were recommended (Dube et al., 2016; Biggs et al., 2014).

In the face of recent prevalent drought and reduced crop production in African regions, regional integrations proved successful in accelerating agricultural productivity growth, market development and food security in Africa (Garnett et al., 2013; Dube et al., 2016). Thus, West Africa recognised and embraced the importance of regional technology transfers, agricultural commodity trade, food security monitoring and agricultural planning (Haggblade et al., 2015). Therefore, strengthening of regional collaboration through the Southern Africa Development Community (SADC) and increased trade with other regions are fundamental to promote food security in arid regions (Dalin & Conway, 2016; Haggblade et al., 2015; Dube et al., 2016). Therefore, it is important to understand how climate variability affects agricultural productivity and how regional and extra-regional food trade can promote the region's capacity to deal

with climate-related challenges (Dalin & Conway, 2016; Haggblade et al., 2015; Hussein & Nelson, 2016). Over the years, regional food trade proved to be efficient in terms of water use, however, it but may be unsustainable because water-productive exporters, like South Africa, rely on increasingly stressed water resources (Dalin & Conway, 2016; Biggs et al., 2014; Haggablade et al., 2015). Dalin and Conway (2016) concur that imports from the rest of the world play a crucial role in the region's food supply particularly during severe droughts. Consequently, this demonstrates how trade can efficiently redistribute water resources across continents in response to a sudden gap in food production and through regional and global integration. There are opportunities for improved water-efficiency and sustainability of the region's food supply through trade (Dalin & Conway, 2016; Haggablade et al., 2015).

Through the international trade of food commodities, countries virtually export or import the water used for food production, known as “virtual water” (Tamea et al., 2014). A concept of the trade of virtual water is applicable to the context of arid and semi-arid regions such as in Southern Africa. In Saudi Arabia, for example, where domestic agricultural enterprise remains a state priority despite extreme water scarcity, a shift to overseas food production to meet domestic demand proved to have significant benefits for water and energy use, as well as for local labour markets (Gridle et al., 2015).

The role of ‘virtual water’ within a broader policy framework is also implemented in Egypt through crop production and international trade, where a substantial amount of ‘virtual water’ is embodied in wheat and maize imports (El-Sadek, 2010). The global trade of goods is associated with a virtual transfer of the water required for their production (Carr et al., 2013; Tamea et al., 2014).

Understanding the virtual water trade concept and strategy is important for formulating informed policies for improving water use efficiency at different levels (El-Sadek, 2010). The way changes in trade affect the virtual redistribution of freshwater resources has been recently documented through the analysis of the virtual water network (Carr et al., 2013). However, some of the major players have shown significant changes in the virtual water imports and exports associated with those commodity groups (Konar et al., 2011; Carr et al., 2013; Dalin & Conway, 2016). For instance, in a research conducted by Carr et al. (2013) on how the global trade of

goods is associated with a virtual transfer of the water required for their production. The findings of the research reveal that China switched from being a net exporter of virtual water associated with other products (non-edible plant and animal products typically used for manufacturing) to being the largest importer, accounting for 31% of the total water virtually transported with these products. Conversely, in the case of The United states of America, the commodity proportions have remained overall unchanged throughout the research period: the virtual water exports from The United States of America are dominated by plant products, whereas the imports comprises mainly of animal and luxury products (Carr et al., 2013).

In Africa, an empirical analysis of the relationships between virtual water trade, population and development was conducted by a number of researchers (Konar et al., 2011; Dalin & Conway, 2016; Biggs et al., 2014; Grabowski & Haggblade, 2016). Interestingly, in a research conducted by Konar et al. (2011) for instance, it was established that increases in virtual water imports do not necessarily lead to increases in population growth nor do they diminish human welfare (Konar et al., 2011; Dalin & Conway, 2016) which is contrary to the view of other researchers (Dalin & Conway, 2016; Biggs et al., 2014; Grabowski & Haggblade, 2016). Therefore, countries with limited water resources obtain supplementary agricultural water requirements from foreign sources.

Globally, there is a general observation that a correlation exists between increased crop exports and increased crop water use efficiency. The international trade network thus implies a network of virtual water flows from exporting to importing countries (Tamea et al., 2014; Grabowski & Haggblade, 2016; Dalin & Conway, 2016). Internal African trade proved to be much more efficient in terms of embodied water resources than any other region in the world (Konar et al., 2011; Dalin & Conway, 2016; Biggs et al., 2014; Grabowski & Haggblade, 2016). Thus, internal African trade patterns may be compensating for poor internal agricultural production systems. Population, gross domestic product and geographical distance are the major drivers of virtual water fluxes, with agricultural production as a minor contribution given by exporting countries (Tamea et al., 2014). Such drivers have become relevant for an increasing number of countries throughout the years, with an increasing variance explained by the distance between countries and a decreasing role of the gross domestic product (Tamea et al.,

2014; Carr et al., 2013; Konar et al., 2011). Trade of ‘virtual water’ through agricultural products and its adoption through foreign direct investment (FDI) in food production have potential strategies for water-scarce countries seeking food security (Gridle et al., 2015; Tamea et al., 2014; Carr et al., 2013; Konar et al., 2011).

Agriculture is the engine for socio-economic growth in Africa; water is fundamental to agriculture-based rural livelihoods. However, due to lack of water, low crop yield and poor soils, are among other constraints that add to the difficulties for sustainable farming and incomes (Macauley & Ramadjita, 2015). Thus the region comprises of 43% arid and semi-arid area, which is projected to increase due to climate change (Hadebe et al., 2017; Food and Agricultural Organisation, 2016; Grain SA, 2015). Growing demands on limited water supplies from domestic, industrial and environmental uses may continue, leading to a decline in water availability for food production. Thus, semi-arid and arid countries continue to increase net imports of food (Ringler and Zhu, 2015; Hadebe et al., 2017; Food and Agricultural Organisation, 2016).

7.9 Child mortality due to water pollution

A safe, reliable, affordable, and easily accessible water supply is essential for good health, but for several decades almost 1 billion people in developing countries have lacked access to such a supply (Hunter et al., 2010). Some of the reasons for the limited progress towards universal access to an adequate water supply include high population growth rates in developing countries, insufficient rates of capital investment, difficulties in appropriately developing local water resources, and the ineffectiveness of institutions mandated to manage water supplies (in urban areas) or to support community management (in rural areas) (Bashier et al., 2015; Hunter et al., 2010). The gross domestic product per capita (GDP) and the proportion of the population without access to improved water are highly correlated with infant mortality (Hunter et al., 2010).

Poor water supply impacts health by causing acute infectious diarrhoeal diseases and it accounts for some 1.7 million deaths per annum worldwide (Ashbolt, 2004; Walker et al., 2013; Derne et al., 2015). Nine out of 10 diarrhoeal related deaths are in children from developing countries (Mattioli et al., 2012; Palaniappan et al., 2012; Ashbolt, 2004). Therefore, failure to provide adequate water and functional sanitation could

lead to disastrous impacts on the health and social wellbeing of communities, the environment and the economy of the country (Department of Water Affairs, 2012). Water service providers are therefore legally mandated to ensure the prevention of the pollution of water sources, thereby preventing specific water-borne diseases and deaths (Gleick & Ajami, 2014; World Health Organisation, 2004). Effluent discharged into natural water resources accounts for one of the biggest contributors to the water resource contamination which is associated with the risk of water-borne diseases (National Institute for Communicable Diseases, 2014; Ferrar et al., 2013; Khan et al., 2013).

One of the eight Millennium Development Goals (MDG 4) was to reduce child mortality (United Nations, 2000). The reduction in child mortality is measured by the infant and under-5 mortality rates by 2015. The infant mortality rate (IMR) is defined as the probability of dying within the first year of life and refers to the number of babies under 12 months who die in a year, per 1,000 live births during the same year. Similarly, the under-five mortality rate (U5MR) is defined as the probability of a child dying between birth and the fifth birthday. The U5MR refers to the number of children under five years old who die in a year, per 1,000 live births in the same year (Phetoane, 2012). There are actually two very different mortality rates, both of which are called "under-5 mortality rate." They are both measures of the risk of death in children less than 5 years of age, but they are calculated differently and result in very different numbers (Phetoane, 2012).

(i) The first is an age-specific mortality rate for children less than 5 years of age.

(ii) The second "under-5 mortality rate" is defined as the probability of dying between birth and the fifth birthday expressed per 1,000 live births. It is not a true rate, but rather a cumulative incidence of mortality during the first 5 years of life. It is usually calculated using life table techniques from survey questions asking mothers about children born within 5 years before the survey. In non-emergency situations, this cumulative incidence of mortality is the more used measure; it is the measure of child mortality in major publications such as UNICEF's State of the World's Children. Usually, public health workers in stable populations will be most familiar with this indicator and will be surprised

to see epidemiologists expressing child mortality as an age-specific mortality rate.

There is a strong relationship between access to water and sanitation technologies and both child disease and child mortality (Gunther et al., 2010). The risk of water borne diseases is constantly growing and is attributed to non-compliance with wastewater treatment regulations set by government (Department of Water Affairs, 2012; Karsten, nd). This was confirmed through the Bloemhof incident in South Africa in 2014. According to the National Institute for Communicable Diseases (2014), there was an outbreak of diarrhoeal disease in Bloemhof Municipality, North West Province, South Africa, which was reported in May 2014. According to the local Healthcare services an increase in the number of patients presenting with diarrhoea was observed; numerous schools closed after more than 100 school children were ill with diarrhoea; over 300 cases of diarrhoea were seen at healthcare services, with 7 persons (mostly young children) requiring admission to hospitalisation. Furthermore, a total of three deaths had been reported since the outbreak began; all were children younger than 2 years of age with diarrhoea complicated by dehydration who presented late to healthcare facilities. Thus, there have been problems with safe water quality and supply in the area, with reports of sewage spillage and possible water supply contamination. Accordingly, diarrhoeal disease is the second most common contributor to the disease burden in developing countries (Kotloff et al., 2013; Walker et al., 2013; Hunter et al., 2010). For instance, diarrhoea is one of the leading causes of morbidity and mortality in under-five children in South Africa (Bradshaw et al., 2003; Nanna et al., 1997; Reid et al., 2016). Most disease burdens occur in developing countries on young children, with diarrhoea resulting in 17% of all deaths of children under 5 years of age (Liu et al., 2015; Walker et al., 2013; Kotloff et al., 2013). Therefore, the availability of adequate water and sanitation infrastructure lowers the odds of children suffering from diarrhoea by 7% to17 %, and reduces the mortality risk for children under the age of five by about 5% to 20% (Gunther et al., 2010).

Access to improved water services is likely to be accompanied by improvements in other services. There is a broad statistical relationship that exists between improved water services and lower infant mortality for developing countries (Cheng et al., 2012; Jeuland et al., 2013). Efforts must be made to improve access to safe and sustainable water supplies in developing countries (Gleick and Ajami, 2014; Cosgrove and

Rijsberman, 2014). Given the public health burden and the costs of the health system, the health sector should collaborate with other sectors in demanding accelerated progress towards global access to safe water (Bradley & Bartram, 2013; Dora et al., 2015; Hunter, 2010).

7.10 Conclusion

This chapter presented the importance of water infrastructure for service delivery particularly water provision. In view of this fact, the literature review has interrogated the impact of climate change on the hydrological cycle, notably on recent droughts and floods. Importance of water infrastructure as a vehicle for socio-economical development, water quality and availability to rural communities was discussed. Furthermore, the importance of water for food production, poverty alleviation and population health was addressed. This review is based on the Agency and Stewardship theories since governments are entrusted with the responsibility of providing water to the public on a sustainable basis. The next chapter presents the research design and methodology which involves research design, study area, target population, sampling design, data collection and data analysis which response to the research questions and objectives of this research. It also includes data interpretation and discussion of the findings which eventually address all the research objectives of this research.

CHAPTER 8

RESEARCH DESIGN AND METHODOLOGY

8.1 Introduction

This chapter presentes the research design and methodology. The research design, research study area, target population, sampling design, data collection and data analysis were discussed. Furthermore, the regression model, probability distribution and normality test which were used to analyse data for this research, are introduced.

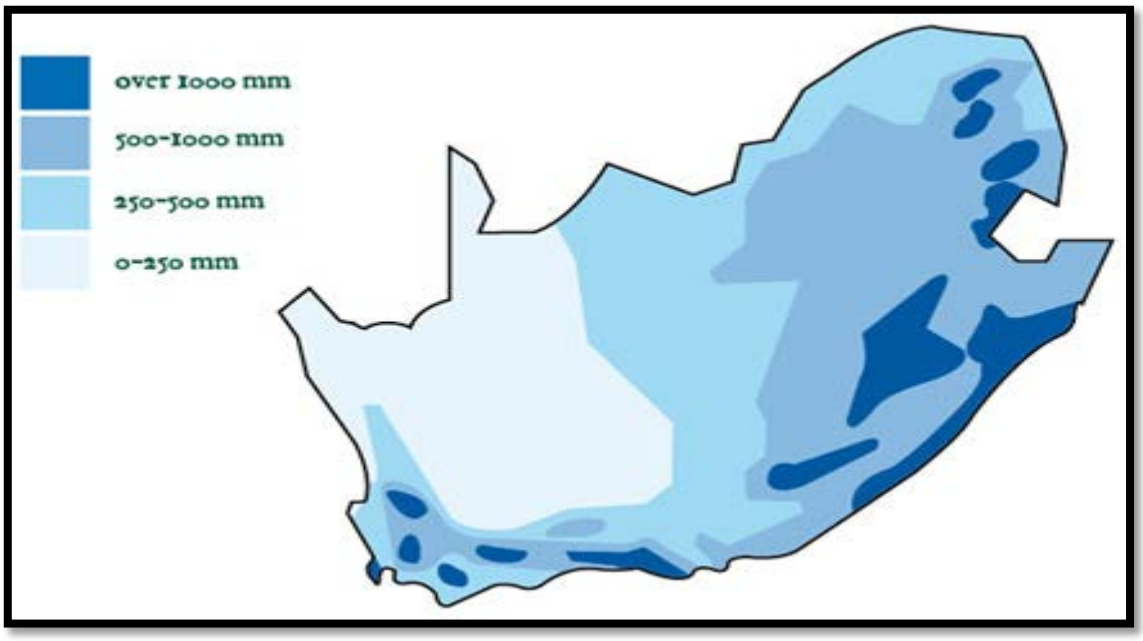
8.2 Research design

The research followed a positivist research paradigm which involves the objective measurement of a relationship between variables (Reale, 2014; Schrag, 1992). Therefore, based on the positivist research, the researcher employed a quantitative research approach in order to measure the relationship between variables in the research questions (Bauer & Gaskell, 2000). A causal research approach was used in order to determine whether water infrastructure financing, water governance and water accountability contribute to water provision in South Africa. Causal research was ideal for this research because infrastructure financing is perceived to have a cause and effect relationship with water provision (Babbie, 2015; Mertens, 2014). Therefore, in addition, the researcher sought for the effect of other variables such as financial governance and accountability on water provision.

8.3 Research study area

The study area for this research is the Republic of South Africa. All nine provinces were studied with the intent to understand the relationship between water infrastructure financing, governance and accountability with water provision.

Figure 8.1: The Distribution of Mean Annual Rainfall in South Africa



Source: Rand Water, 2017.

The amount of water on earth is unevenly distributed across the earth and South Africa receives an annual rainfall of 492 millimetres whereas the rest of the earth receives 985 millimetres on average (Rand Water, 2017). Thus, South Africa is classified as a water-stressed country with an uneven distribution of rainfall across South Africa. Figure 8.1 above presents the uneven distribution of rainfall in South Africa where the eastern half of the country is much wetter compared to the western half due to the nature of the weather conditions. The north-east, south east and the south-west parts of the country have a significant amout of rain in the renge of 500mm/annum to over 1000mm/annum. On the contrary, western and central part of the country has less rain fall distribution in the range 0 to 500mm (Figure 8.1). As a results, areas with the highest economic activities have limited rainfall even though the make a significant contribution the economy of the country. South Africa also experiences alternating periods of droughts and floods which affects the amount of water across South Africa (Whale Coast Concervation, 2017). Furthermore, hot and dry conditions result in a high evaporation rate. Therefore research predict that with global warming, South Africa will experience much wetter wet seasons and much

drier dry seasons, resulting in an increase in floods and droughts (Rand Water, 2017; Whale Coast Concervation, 2017).

8.4 Target population

Population is defined as the complete group of objects or elements relevant to the research project (Berg, 2004; Bryman, 2015). Therefore, the population for this research encompassed the data South African population, focusing on the secondary archival data available from the public domain of the selected institutions: trends of infrastructure financing from Trans-Caledon Tunneling Authority (TCTA), Poverty Incidence at provincial level from the Department of Agricultural, Forestry and Fisheries (DAFF) and StatsSA, Development indicators from the World Bank, and Cereal Production from the Food and Agricultural Organisation of the United Nations (FAOUN), for the period between 1994 and 2014 (21 years).

8.5 Sampling design

A Sample is defined as a small part of anything, intended to show the quality, style or nature of the whole specimen (Green, 1979; Scheaffer et al., 2011). A sample is collected from a large population and it serves as an estimate for the situation or outcome in a bigger group (Levy & Lemeshow, 2013; Morse, 2010). The sample for this research covered a period of 21 years (1994-2014), this is because there are few records for water infrastructure financing prior to 1994 from the archival records of the Department of Water and Sanitation and the Trans-Caledon Tunneling Agency. Therefore, a purposeful or judgmental sampling approach was used to select the 20 year period of data to ensure that the researcher is able to source all the required data.

8.6 Data collection procedure

The research data were collected from secondary archival data over a period of 21 years (1994-2014). Data were collected mainly from the TCTA, DAFF, the World Bank, StatsSA, as well as FAOUN.

8.7 Type of data collected

The data that were collected were those that related to the research objectives and that were used for analysis. The data include: water provision data, water infrastructure finance data, financial governance data and financial accountability data.

8.8 Data analysis technique

Given that the research design of this research is causal, the data analysis technique was quantitative and it employed the multiple regression analysis in order to examine the relationship between water infrastructure financing, governance, accountability and water provision in South Africa. The statistical package for social sciences (SPSS) was used to conduct the regression analysis. The regression model which was used in this thesis is explained below.

The regression model

Regression modeling is a statistical process for estimating the relationships among variables (Abraham & Ledolter, 2006). It includes many techniques for modeling and analyses of several variables, when the focus is on the relationship between a dependent variable and one or more independent variables (Burton et al., 1998). Regression analysis generates an equation to describe the statistical relationship between one or more predictor variables and the response variable (Frost, 2013; Harrel, 2015). . Thus it involves the following variables:

- The **unknown parameters**, denoted as **β**, which may represents the regression coefficient.
- The **independent variables**, **X**.
- The **dependent variable**, ***Y*.**

Thus, a regression model relates ***Y*** to a function of **X** and **β**.

Regression analysis is also used to understand which among the independent variables are related to the dependent variable and to explore the forms of these relationships (Scott, 2012). In restricted circumstances, it can be used to infer causal relationships between the independent and dependent variables, as well as to

characterise the variation of the dependent variable around the regression function which can be described by a probability distribution (Scott, 2012). However the usage of regression in this research was to find if a relationship exists between depedent and independent variables, and not causality.

For this research, water provision was regarded as a dependent variable (Y), while the independent variables (X) included:

(i) Water Asset Financing (X_1),

(ii) Effective Governance (X_2), and

(iii) Accountability (X_3).

Other independent variables which were representative of effective governance were also tested and these include corruption, regulation and violence. Accountability in association with voice was tested as an independent variable against water provision which was an dependent variable (Y).

Similarly, in order to address the research question 4, water provision and poverty allevation and cereal production was also tested using the regression analysis, where povety allevation and cereal production were a dependent variables (Y) while water provision was an independent variable (X).

The following describes the model of analysis used for the thesis research questions 1 – 4 and their associated hypotheses.

Analysis of Data on Research Question 1, 2 and 3:

Test 1 - 3: Research Question 1, 2 and 3 and Hypotheses 1 – 3.

Regression Results on Test 1 – 3 for **Research Question 1, 2 and 3:**

Test 1:

Research question 1: How does water assets financing impact on water provision?

Hypothesis 1

$H0_1$: water assets financing has no significant impact on water provision

Test 2:

Research question 2: How could governance affect water provision?

Hypothesis 2

$H0_2$: governance has no significant impact on water provision

Test 3:

Research question 3: How could accountability affect water provision?

Hypothesis 3

$H0_3$: accountability has no significant impact on water provision

The Regression Model:

$$\gamma = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 + \beta_5\chi_5 + \beta_6\chi_6 + \beta_7\chi_7 + \varepsilon$$

Where:

γ **=** Water provision (WaterP) (dependent variable)

β_0 **=** regression intercept

β_1 **-** β_6 **=** regression coefficients

χ_1 **=** Water asset finance (WAFin) (independent variable 1)

χ_2 **=** Governance effectiveness (GovEffect) (independent variable 2)

χ_3 **=** Accountability (ACC) (independent variable 3)

χ_4 **=** Corruption (Corr) (control variable)

χ_5 **=** Regulation (Regu) (control variable)

χ_6**=** Violence (control variable)

χ_7 **=** Voice (control variable)

Decision Criterion:

Tested at an alpha (α) of 0.05:

If the P value is less than or equal to 0.05 reject H0 and accept H1.

If the P value is more than 0.05 accept H0

Analysis of Data on Research Question 4:

What role could water provision play in poverty alleviation and development in South Africa?

In testing the research question 4, two tests were conducted with two hypotheses.

Hypothesis 4 A

$H0_{4a}$: there is no significant relationship between water provision and incidence of poverty in South African

The Regression Model:

$$\gamma = \beta_0 + \beta_1\chi_1 + \varepsilon$$

Where:

γ **=** Poverty incidence (dependent variable)

β_0 **=** regression intercept

β_1 **=** regression coefficients

χ_1 **=** Water provision (independent variable)

In the above analysis, other variables that affect the incidence of poverty were held constant and were accounted for, by the error term (ε) in the regression model. The research only intended to know if there is a relationship and not a causality, between water provision and incidence of poverty, hence the use of single independent variable (water provision).

In addition to the main test above for research question 4, the researcher decided to add a second test and hence a second hypothesis, which analysed the effect of water provision on cereal production. This was necessary since, the literature indicate that availability of water may enhance agricultural output which also helps in rural poverty alleviation Department of Agriculture (1997).

Hypothesis 4 B

H0: there is no relationship between water provision and cereal production in South Africa

The Regression Model:

$$\gamma = \beta_0 + \beta_1\chi_1 + \varepsilon$$

Where:

γ **=** cereal production (dependent variable)

β_0 **=** regression intercept

β_1 **=** regression coefficients

χ_1 **=** Water provision (independent variable 1)

In the above analysis, other variables that affect cereal production were held constant and were accounted for, by the error term (ε) in the regression model. The research only intended to know if there is a relationship and not a causality, between water provision and incidence of poverty, hence the use of single independent variable (water provision).

8.9 Probability distribution

Probability distribution is a mathematical description of a random phenomenon in terms of the probabilities of events (Bendat & Piersol, 2011; Papoulis and Pillai, 2002). It is defined in terms of an underlying sample space, which is the set of all possible outcomes of the random phenomenon being observed (Benjamin & Cornell, 2014). Where the sample space may be the set of real numbers or a higher-dimensional vector space or it may be a list of non-numerical values; for example, the sample space of a coin flip would be (Scott, 2012; Bendat & Piersol, 2011). A probability distribution was used for this research in order to test the significance of all independent variables for this research using the p-value of 0.05% level of significance as explained below.

The p-value

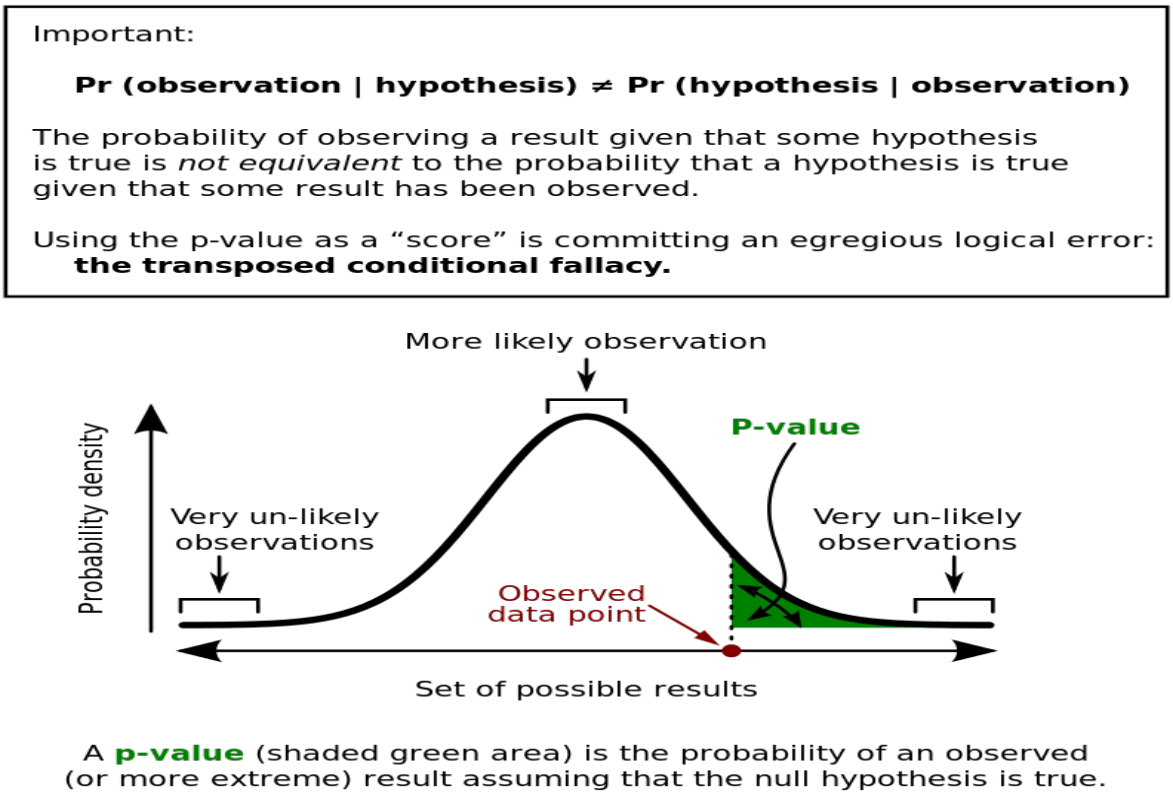
The *p*-value is defined as the probability of obtaining a result equal to or "more extreme" than what was actually observed, when the null hypothesis is true (Wasserstein et al., 2016 & Hubbard, 2004). In frequentist inference, the *p*-value is widely used in statistical hypotheses testing, specifically in null hypothesis significance testing (Everitt, 1998). In this method, as part of experimental design, before performing the experiment, one first chooses a model (the null hypothesis) and a threshold value for *P*, called the significance level of the test, traditionally 5% or 1% and denoted as alpha (*α)* (Nuzzo, 2014; Rice, 1989).

If the *p*-value is less than or equal to the chosen significance level (*α*), the test suggests that the observed data is inconsistent with the null hypothesis, so the null hypothesis must be rejected (Everitt, 1998). However, that does not prove that the tested hypothesis is true. When the *P*-value is calculated correctly, this test guarantees that

the Type I error rate is at most α. Where in statistical hypothesis testing, a type I error is the incorrect rejection of a true null hypothesis a false positive, while a type II error is incorrectly retaining a false null hypothesis, a false negative (Explorable.com, 2016). Therefore, a type I error is detecting an effect that is not present, while a type II error is failing to detect an effect that is present. For typical analysis, using the standard $\alpha = 0.05$ cut-off, the null hypothesis is rejected when $P < .05$ and accepted when $p > .05$ (Rice, 1989) The P-value does not, in itself, support reasoning about the probabilities of hypotheses but is only a tool for deciding whether to reject the null hypothesis (Frost, 2013; Rice, 1989). The *P*-value is used in the context of null hypothesis testing in order to quantify the idea of statistical significance of evidence. It is important to note that the statistical significance of a result does not imply that the result is scientifically significant as well (Montgomery et al., 2015).

According to Figure 8.1, the result is said to be statistically significant if it allows us to reject the null hypothesis. That is, as per the reduction and absurdum reasoning, the statistically significant result should be highly improbable if the null hypothesis is assumed to be true (Rice, 1989). The rejection of the null hypothesis implies that the correct hypothesis lies in the logical complement of the null hypothesis. However, unless there is a single alternative to the null hypothesis, the rejection of the null hypothesis does not tell us which of the alternatives might be the correct one (Rice, 1989; Frost, 2013).

Figure 8.2: The Presentation of the p-value analysis



Source: Rice (1989).

8.10 Normality Test

A Normality Test is used to determine whether sample data have been drawn from a normally distributed population (within some tolerance) (Delmail et al., 2011; Fellows & Liu, 2015). A number of statistical tests, such as the Student's t-test and the one-way and two-way ANOVA require a normally distributed sample population (Ghasemi & Zahediasl, 2012; Delmail et al., 2011). Because statistical errors are common in scientific literature and about 50% of the published articles have at least one error, the assumption of normality needs to be checked for many statistical procedures, namely parametric tests, because their validity depends on it (Ghasemi & Zahediasl, 2012). Thus a normality test was used for this research on order to check whether the distribution is normal or not.

8.11 Heteroskedasticity Test

Heteroskedasticity, in statistics, is when the standard deviations of a variable, monitored over a specific amount of time, are non-constant (McCulloch, 1985).

Statistically, heteroskedasticity which is also spelled heteroskedasticity, refers to the error variance, or dependence of scatter, within a minimum of one independent variable within a particular sample (Vogt & Johnson, 2011). These variations can be used to calculate the margin of error between data sets, such as expected results and actual results, as it provides a measure for the deviation of data points from the mean value (Halunga et al., 2017; Song et al., 2017)). For this research, White's heteroskedasticity Test and Breusch-Pagan heteroskedasticity Test were both employed.

8.11.1 White's Test

The White heteroskedasticity test is a statistical test that establishes whether the variance of the errors in a regression model is constant (White, 1980). In cases where the White test statistic is statistically significant, heteroskedasticity may not necessarily be the cause; instead the problem could be a specification error. In other words, the White test can be a test of heteroskedasticity or specification error or both.

8.11.2 Breusch-Pagan Test

The Breusch-Pagan heteroskedasticity test is one of the most common tests for heteroskedasticity (Waldman, 1983). It begins by allowing the heteroskedasticity process to be a function of one or more of the independent variables, and it's usually applied by assuming that heteroskedasticity may be a linear function of all the independent variables in the model (Maddala & Lahiri, 1992).

8.12 Conclusion

This chapter presented the research design and methodology which was followed in order to address the research questions and objectives of this research. The context of the research study area was presented in order to provide the water resource perspective in the context of South Africa. The next chapter presents the actual results obtained following the statistical analysis employed for this research.

CHAPTER 9

DATA ANALYSIS AND FINDINGS

9.1 Introduction

This section presents a structured data analysis, interpretation and discussion of findings. In order to enhance articulation with the research questions set out from the on start, data analysis and interpretation falls into two major sections. Section 9.2 presents the data analysis and interpretation of results on the first three major research questions and associated hypotheses (which are questions 1 – 3). This is arranged as such since the first three research questions are key to providing an answer to the focus of the research. The questions 1 – 3 are also interconnected as they possess independent variables (water finance, accountability and governance) that should be examined together to see their relative impact on water provision.

Following this, the data analysis and interpretation for the sub-research question 4 are presented in section 9.3. Question 4 deserved separate analysis given that its dependent variable (poverty) is different from the dependent variable for questions 1 – 3, which is water provision. This means that question 4 and associated two hypotheses is meant to provide additional insight into the outcomes of questions 1 – 3 and to enhance the provision of research contribution. Whilst questions 1 – 3 has one associated research hypothesis each, question 4 is uniquely associated with two research hypotheses to provide a substantive insight on why water provision might contribute to poverty alleviation.

9.2 Analysis of Data on Research Question 1, 2 and 3:

Given the introduction above, this section presents the OLS test and analyses of research questions 1 – 3 with associated hypotheses 1 – 3. Before presentation of the analysis, the relevant regression model is first presented below.

The Regression Model:

$$\gamma = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 + \beta_5\chi_5 + \beta_6\chi_6 + \beta_7\chi_7 + \varepsilon$$

Where:
γ **=** Water provision (WaterP) (dependent variable)

β_0 = regression intercept

β_1 - β_6 = regression coefficients

χ_1 = Water asset finance (WAFin) (independent variable 1)

χ_2 = Governance effectiveness (GovEffect) (independent variable 2)

χ_3 = Accountability (ACC) (independent variable 3)

χ_4 = Corruption (Corr) (control variable)

χ_5 = Regulation (Regu) (control variable)

χ_6= Violence (control variable)

χ_7 = Voice (control variable)

Since this first part of analysis contains and tests three different research questions and associated 3 hypotheses; this part of the analysis is therefore titled as Test 1 – 3 for clarity in following the different sections of the analysis. Questions 1 – 3 are reiterated and related hypotheses are introduced before the test as follows:

Test 1 - 3: Research Question 1, 2 and 3 and Hypotheses 1 – 3.

9.2.1 Regression Results on Test 1 – 3 for Research Question 1, 2 and 3:

Test 1:

Research question 1: How does water assets financing impact on water provision?

Hypothesis 1

$H0_1$: water assets financing has no significant impact on water provision

Test 2:

Research question 2: How could governance affect water provision?

Hypothesis 2

$H0_2$: governance has no significant impact on water provision

Test 3:

Research question 3: How could accountability affect water provision?

Hypothesis 3

$H0_3$: accountability has no significant impact on water provision

Decision Criterion:

Tested at an alpha (α) of 0.05:

If the P value is less than or equal to 0.05 reject H0 and accept H1.

If the P value is more than 0.05 accept H0

Table 9.1: OLS Results on Tests 1 – 3: Research Question 1, 2 and 3 and Hypotheses 1 – 3.

Model 1: OLS, using observations 1994-2014 (T = 21)
Dependent variable: WP

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	107.241	2.81937	38.0372	<0.00001	***
WAFin	9.5444e-08	4.73587e-08	2.0153	0.06503	*
GovEffect	4.82474	2.68199	1.7989	0.09527	*
Corr	-4.07648	1.35552	-3.0073	0.01010	**
Regu	1.30219	1.0177	1.2795	0.22307	
Violence	-3.50586	1.28518	2.7279	0.01725	**
ACC	124.388	34.8449	3.5698	0.00342	***
Voice	247.928	93.3298	2.6565	0.01977	**

Mean dependent var	87.66667	S.D. dependent var	5.534739
Sum squared resid	5.872951	S.E. of regression	0.672135
R-squared	0.990414	Adjusted R-squared	0.985252
F(7, 13)	191.8801	P-value(F)	4.34e-12
Log-likelihood	-16.41897	Akaike criterion	48.83795
Schwarz criterion	57.19413	Hannan-Quinn	50.65145
Rho	-0.426867	Durbin-Watson	2.805281

***Validity Tests on Test* 1 – 3**

Table 9.2 Normality Test on Test 1 – 3

Test for normality of residual -
Null hypothesis: error is normally distributed
Test statistic: Chi-square(2) = 0.328148
with p-value = 0.848679

```
Frequency distribution for uhat1, obs 1-21
number of bins = 7, mean = -2.70683e-014, sd = 0.672135

       interval          midpt   frequency    rel.     cum.

          < -0.74879  -0.91436       4     19.05%   19.05% ******
 -0.74879 - -0.41766  -0.58323       0      0.00%   19.05%
 -0.41766 - -0.086534 -0.25210       3     14.29%   33.33% *****
-0.086534 -  0.24459   0.079030      5     23.81%   57.14% ********
  0.24459 -  0.57572   0.41016       7     33.33%   90.48% ***********
  0.57572 -  0.90685   0.74129       1      4.76%   95.24% *
         >=  0.90685   1.0724        1      4.76%  100.00% *

Test for null hypothesis of normal distribution:
Chi-square(2) = 0.328 with p-value 0.84868
```

Table 9.3a Heteroskedasticity Test on Test 1 – 3

White's test for heteroskedasticity

```
White's test for heteroskedasticity
OLS, using observations 1994-2014 (T = 21)
Dependent variable: uhat^2
------------------------------
White's test for heteroskedasticity -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 13.7134
with p-value = P(Chi-square(14) > 13.7134) = 0.471275

                  coefficient      std. error    t-ratio  p-value
  ------------------------------------------------------------------
  const            10.4224          9.61365       1.084   0.3199
  WAFin            2.16945e-08     1.08576e-07   0.1998  0.8482
  GovEffect        20.3834         41.9128        0.4863  0.6440
  Corr             -4.21897         2.77132      -1.522   0.1787
  Regu             -4.75288         4.86898      -0.9762  0.3667
  Violence         -1.27587         1.38664      -0.9201  0.3930
  ACC            -400.240          720.253        -0.5557  0.5985
  Voice          1006.73           1921.07         0.5240  0.6190
  sq_WAFin          0.000000         0.000000     -0.7876  0.4609
  sq_GovEffect    -17.2126         34.6499       -0.4968  0.6370
  sq_Corr           3.45324         2.56739       1.345   0.2272
  sq_Regu           4.90915         4.10555       1.196   0.2769
  sq_Violence      -2.95174         2.42719      -1.216   0.2696
  sq_ACC          384.627          716.368         0.5369  0.6106
  sq_Voice      -2811.98          5575.76         -0.5043  0.6320


  Unadjusted R-squared = 0.653019

Test statistic: TR^2 = 13.713393,
with p-value = P(Chi-square(14) > 13.713393) = 0.471275
```

Table 9.3b Heteroskedasticity Test on Test 1 – 3
Breusch-Pagan test for heteroskedasticity

```
Breusch-Pagan test for heteroskedasticity
OLS, using observations 1994-2014 (T = 21)
Dependent variable: scaled uhat^2
------------------------------
Breusch-Pagan test for heteroskedasticity -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 5.40561
with p-value = P(Chi-square(7) > 5.40561) = 0.610593

               coefficient     std. error     t-ratio    p-value
  ------------------------------------------------------------------
  const         2.55361         5.20833        0.4903    0.6321
  WAFin        -4.69150e-08     8.74874e-08   -0.5362    0.6008
  GovEffect    -4.01617         4.95454       -0.8106    0.4322
  Corr         -2.81126         2.50410       -1.123     0.2819
  Regu          0.443004        1.88003        0.2356    0.8174
  Violence     -1.01898         2.37417       -0.4292    0.6748
  ACC           9.67154        64.3704         0.1502    0.8829
  Voice       -15.2362        172.412         -0.08837   0.9309

  Explained sum of squares = 10.8112
Test statistic: LM = 5.405607,
with p-value = P(Chi-square(7) > 5.405607) = 0.610593
```

9.2.2 Interpretation of Results from the test of hypotheses 1, 2 and 3 - Research Question 1, 2 and 3

Table 9.1 is the OLS results on the three major research questions and the associated three hypotheses, which are:

Research question 1: How does water assets financing impact on water provision?

Hypothesis 1

$H0_1$: water assets financing has no significant impact on water provision

Research question 2: How could governance affect water provision?

Hypothesis 2

$H0_2$: governance has no significant impact on water provision

Research question 3: How could accountability affect water provision?

Hypothesis 3

$H0_3$: accountability has no significant impact on water provision

For each of the three research questions and hypothesis, the OLS was tested at an alpha (α) of 0.05 and the associated decision rule is to reject the null hypothesis if the *P* value turns to be less than or equal to 0.05 and to accept the null hypothesis if the *P* value turns out to be more than 0.05. The OLS results in Table 9.1 revealed interesting findings to assist with further research and policy making. Three major independent variables (water asset finance, governance effectiveness and accountability) from the three major questions were tested for association with water provision (the dependent variable). Surprisingly, whilst a relationship does exist between water asset finance and water provision, the resulting P value for water asset finance is 0.06 (*P*=0.06), which shows lack of significant impact on water provision. Similarly, the resulting P value for governance is 0.09 (*P*=0.09), which shows that the relationship between governance and water provision is not significant within the context of the sample of data tested. Therefore, based on the *P*-value for water asset finance and governance which are higher than the research alpha of 0.05, the first and second null hypotheses, which relates to water asset finance and governance is accepted. This shows that, from the analysis, there is no significant relationship between water asset finance and water provision and that there is no relationship between governance and water provision.

The third major independent variable (accountability), however, showed a *P*-value of less than 0.05 with *P*=0.003. Therefore, based on this low P-value, the third null hypothesis is rejected. This result shows that accountability is significantly related with water provision. Furthermore, the regression coefficient of 124.38 on accountability shows that a one percent increase in accountability results in more than 124% increase in water provision.

It is also important to mention the statistical results arising from the control variables (corruption, regulation, violence and voice). Whilst there is a relationship between regulation and water provision, the relationship is not significant since the P value for regulation is P=0.22 which is higher than 0.05. On the contrary, corruption, violence and voice are significantly related with water provision at the following P values: corruption, P=0.01; violence, P=0.01 and voice, P=0.01. The regression coefficient associated with the control variables is also worth mentioning. Although regulation is not significantly related, the regression coeffient shows that a 1% increase in related regulation would result in 1.3% increase in water provision. A one percent increase in corruption leads to a more than 4% reduction in water provision (this is worthy of noting for policy makers). Similarly, a one percent increase in violence would lead to a more than 3% reduction in water provision (this is also worthy of noting for policy makers and for general public awareness) on the negative impact of destructive violence. Lastly, the coefficients show that a one percent increase in participation of peoples' voice in water management would lead to a more than 249% increase in water provision – the high significant level of P=0.01 attest to this. (this is also worthy of noting for policy makers and for general public awareness)

Furthermore, the validity of the above regression results were tested using two important validity tests namely the normality test and heteroskedasticity test. The normality test shows whether errors are normaly distributed and the heteroskedasticity shows whether the variances are homogeneous or heteroskedastic (non-homogeneous). The null hypothesis for the normality test is that the error is normally distributed. Therefore, since the associated P-value for the null hypothesis is greater than 0.05, the null hypothesis is accepted, showing that errors are normaly distributed, which adds authenticity to the validity of the regression results. Furthermore, the null hypothesis for the heteroskedasticity test shows that heteroskedasticity is not present,

given that the associated P-value is greater than 0.05, the null hypothesis is accepted to confirm that variances are homogeneous – non-heteroskedastic. This again adds another authenticity to the validity of regression results.

9.3 Analysis of Data on Research Question 4

What role could water provision play in poverty alleviation and development in South Africa?

In order to provide an answer to research question 4, two different unique statistical analyses were conducted based on different data availability:

- Question 4 test A. Panel data regression that tests the relationship between water provision and incidence of poverty in nine provinces of South Africa. Panel data was applied here, as there was not enough time series data to generate many time series.
- Question 4 test B. OLS regression using time series observation from 1994 – 2014 on water provision and cereal production; it should be noted here that cereal which produces flour meal (a staple food in South Africa) represents a poverty alleviation tool, which has been confirmed by development authorities as a catalyst for reducing rural poverty (Abdu-Raheem and Worth, 2011; Department of Agriculture, 1997).

Therefore, water provision and cereal production were used as a supportive test to the Test 4 A.

9.3.1 Regression Result on Research Question 4

The Regression Model:

$$\gamma = \beta_0 + \beta_1\chi_1 + \varepsilon$$

Where:

γ **=** Poverty incidence (dependent variable)

β_0 **=** regression intercept

β_1 **=** regression coefficients

χ_1 **=** Water provision (independent variable)

Research questions 4 is substantiated and tested with two different hypotheses – null hypotheses 4a and 4b represented as $H0_{4a}$ and $H0_{4b.}$ therefore, the statistical test in this section is divided into two tests – test 4a and test 4b in consonant with the two hypotheses. These are presented as follows:

Research Question 4

What is the relationship between water provision and poverty alleviation?

Test 4 A.

Hypothesis 4 A

$H0_{4a}$: there is no significant relationship between water provision and incidence of poverty in South African

Table 9.4 Test 4 A Results

Model 1: Fixed-effects, using 27 observations
Included 9 cross-sectional units
Time-series length = 3
Dependent variable: Incidence of Poverty

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	54.2631	4.7333	11.4641	<0.00001	***
waterProv	-0.00880251	0.00295548	-2.9784	0.00843	***

Mean dependent var	42.07037	S.D. dependent var	13.38681
Sum squared resid	2591.086	S.E. of regression	12.34572
R-squared	0.443898	Adjusted R-squared	0.149492
F(9, 17)	1.507773	P-value(F)	0.222661
Log-likelihood	-99.92528	Akaike criterion	219.8506
Schwarz criterion	232.8089	Hannan-Quinn	223.7038
Rho	-0.550863	Durbin-Watson	2.370778

Validity Tests on Test 4 A

Table 9.5 Normality test on Test 4 A

```
Frequency distribution for uhat1, obs 1-27
number of bins = 7, mean = -7.23701e-015, sd = 10.1805
----------------------
Test for normality of residual -
  Null hypothesis: error is normally distributed
  Test statistic: Chi-square(2) = 6.7661
  with p-value = 0.0639437

      interval          midpt   frequency    rel.     cum.

         < -11.499   -13.996         3     11.11%   11.11% ***
  -11.499 - -6.5049  -9.0021         4     14.81%   25.93% *****
  -6.5049 - -1.5106  -4.0077         9     33.33%   59.26% ***********
  -1.5106 -  3.4838   0.98663        2      7.41%   66.67% **
   3.4838 -  8.4782   5.9810         0      0.00%   66.67%
   8.4782 -  13.473   10.975         3     11.11%   77.78% ***
         >=  13.473   15.970         6     22.22%  100.00% *******

Test for null hypothesis of normal distribution:
Chi-square(2) = 6.766 with p-value 0.06394
```

Table 9.6 Heteroskedasticity test on Test 4 A

Distribution free Wald test for heteroskedasticity:
Chi-square(9) = 11.9086, with p-value = 0.218511

Null hypothesis: the units have a common error variance
Asymptotic test statistic: Chi-square(9) = 11.9086
with p-value = 0.218511

Pooled error variance = 95.9662

unit	variance
1	125.107 (T = 3)
2	101.750 (T = 3)
3	66.7624 (T = 3)
4	135.124 (T = 3)
5	41.5306 (T = 3)
6	98.2585 (T = 3)
7	138.433 (T = 3)
8	106.398 (T = 3)
9	50.3318 (T = 3)

Test 4 B: Hypothesis 4 B

Hypothesis 4a above is further supported by hypothesis 4b below, which asserts that water provision may influence cereal production, which the Department of Agriculture has indicated as helping to alleviate poverty as well. Note that cereal production could not be used as a variable to test poverty alleviation here because cereal production data, which are available in times series of 21 years for the whole of South Africa could not match with the poverty alleviation data which are only available in a panel data of three years for 9 provinces of the country. It was possible to test water provision and poverty alleviation in test 4a since both variables are available in a panel of 9 provinces over three years.

Hypothesis 4 B

H0: there is no relationship between water provision and cereal production in South Africa

The Regression Model:

$\gamma = \beta_0 + \beta_1\chi_1 + \varepsilon$

Where:

γ = cereal production (dependent variable)

β_0 = regression intercept

β_1 = regression coefficients

χ_1 = Water provision (independent variable 1)

Table 9.7 Test 4 B Results

Model 1: OLS, using observations 1994-2014 (T = 21)
Dependent variable: CerealProd
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	70838.8	16595.4	4.2686	0.00042	***
WP	553.639	183.452	-3.0179	0.00708	***

Mean dependent var	22303.10	S.D. dependent var	4887.251
Sum squared resid	2.90e+08	S.E. of regression	3906.217
R-squared	0.393114	Adjusted R-squared	0.361173
F(1, 19)	9.107730	P-value(F)	0.007075
Log-likelihood	-202.4237	Akaike criterion	408.8473
Schwarz criterion	410.9363	Hannan-Quinn	409.3007
Rho	0.407445	Durbin-Watson	1.061137

Validity Tests on Test 4 B

Table 9.8 Normality Test on Test 4 B

```
Frequency distribution for uhat1, obs 1-21
number of bins = 7, mean = -1.90561e-012, sd = 3906.22
---------------------------------------
Test for normality of residual -
 Null hypothesis: error is normally distributed
 Test statistic: Chi-square(2) = 0.00224526
 with p-value = 0.998878

      interval         midpt   frequency    rel.     cum

        < -4830.0   -5994.0       3     14.29%   14.29% *****
  -4830.0   -2501.9   -3665.9       3     14.29%   28.57% *****
  -2501.9   -173.74   -1337.8       3     14.29%   42.86% *****
  -173.74   2154.4    990.31        6     28.57%   71.43% **********
   2154.4 -  4482.5    3318.4        4     19.05%   90.48% ******
   4482.5 -  6810.6    5646.5        1      4.76%   95.24% *
          6810.6    7974.6        1      4.76%      100.00% *

Test for null hypothesis of normal distribution:
Chi-square(2) = 0.002 with p-value 0.99888
```

Table 9.9 Heteroskedasticity on Test 4 B

White's test for heteroskedasticity

```
White's test for heteroskedasticity
OLS, using observations 1994-2014 (T = 21)
Dependent variable: uhat^2
------------------
White's test for heteroskedasticity -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 1.0323
  with p-value = P(Chi-square(2) > 1.0323) = 0.596814

              coefficient        std. error     t-ratio  p-value
  ---------------------------------------------------------------
  const         -2.95831e+08       1.39347e+09  -0.2123  0.8343
  WP             7.73713e+06       3.19433e+07   0.2422  0.8114
  sq_WP           -47786.2          182450       -0.2619  0.7964

  Unadjusted R-squared = 0.049157

Test statistic: TR^2 = 1.032300,
with p-value = P(Chi-square(2) > 1.032300) = 0.596814
```

9.3.2 Interpretation of Results from the test of hypotheses 4a and 4b Research Question 4

Table 9.4 presents the panel data regression analysis for research question 4 which sought to establish the relationship between water provision and poverty alleviation. The error term controlled for other independent variables on incidence of poverty was not included in this test, the use of error term is allowed by modelling experts to control for independent variables not present a test (Diamantopoulos, 2006; Rossi, 2014). Tested at an alpha (α) of 0.05, the regression result produced a P-value of P=0.008, which is less that the alpha of 0.05, the null hypothesis 4a is therefore rejected, indicating that a significant relationship exists between water provision and poverty alleviation within the sampled years of research in South Africa. The regression coefficient of -0.008 on water provision means that a one percent increase in water provision would result in 0.008 reduction in incidence of poverty in South Africa; this result is worthy of note for policy makers.

The Department of Agriculture Forestry and Fisheries (1997; 2012) indicates that cereal production helps to alleviate rural poverty, therefore, the analysis was further extended to substantiate if water provision is significantly related to cereal production. Table 9.7 presents the regression analysis for water provision and cereal production. The regression output shows a P-value of P=0.007, which is greater than the alpha of 0.05, therefore the null hypothesis is rejected, which shows that water provision is significantly related to cereal production. The regression coefficient on water provision and cereal production shows a coefficient of 553, this means that a one percent increase in water provision might lead to 553 percent increase in cereal production.

Furthermore, the regression results were tested for validity using major validity tests namely the normality and heteroskedasticity tests (Tables 9.5, 9.6, 9.8 and 9.9). The P-values generated from two normality and two heteroskedasticity tests for tests 4a and test 4b produced a P greater than the alpha of 0.05 (P>0.05), which means that the null hypotheses for normality and heteroskedasticity are accepted. This therefore means that errors are normally distributed and variances are homogeneous, which offers validity to the regression results.

9.4 Discussion of finding emerging from the statistical analyses of the research questions 1 - 4

The following sections present a general discussion of the findings from the preceding statistical analyses for the four research questions.

9.4.1 Discussion of Findings from the Statistical Analysis in Support of Research Question 1

How does water assets financing impact on water provision?

As presented on Table 9.1, the regression statistical analysis indicates that the independent variable, water asset financing (WAFin), is statistically insignificant at *P*-value = 0.06503 which is more than the stated research significance maximum level of 0.05. Based on the results of Table 9.1, this means that water asset financing is statistically insignificant at 0.06503 (or 7%), which is higher than the maximum significance level of 5% set for this research. These results show that water asset financing as a single independent variable does not have a statistically significant impact on water provision. This statistical finding is contradictory to the observation made by a number of researchers who agree that water asset financing has a significant impact on water availability.

Ruiters (2013), for instance, conducted a research in which he reviewed the existing framework for water infrastructure funding and he critically analysed alternative funding models as well as other alternatives for financing water infrastructure in South Africa. His research was responding to existing challenges faced by the South African government of limited water infrastructure investment for the development and management of South African water resources and water services. Furthermore, the government lacked institutional structures and funding models for effective water infrastructure provision (Ruiters, 2013). Ruiters' research identified several funding models for financing publicly provided water infrastructure development projects in South Africa, which viewed government planning, installing and financing infrastructure with pricing at marginal costs or on a loss-making basis, with returns recovered through the taxation system. On the contrary, this research found that water asset financing does not have a statistically significant impact on water provision,

which is different from Ruiters' view that that water infrastructure financing enables water provision (Ruiters, 2013). The difference in both research findings could be attributable to the fact that Ruiters followed a convenient sampling method by targeting specific financial and water related institutions, interviewing specific individuals. His design further adopted the use of questionnaire surveys, interviews, observations, focus group sessions and case researches. To the contrary, this research targeted the entire South Africa, looking at the archival secondary data for the country. Furthermore, Ruiters' research employed a non-parametric test, the Spearman's rank correlation as a test statistic to test a hypothesis of association between funding models and equity, efficiency and effectiveness. However, this research adopted a parametric statistics method, the multiple regression analysis to test the relationship between water infrastructure finance and water provision.

Similarly, Briscoe (1999) also researched the financing of water infrastructure in developing countries. Since water-related infrastructure accounts for a large proportion of all government and public sector spending, Briscoe's research focused more on the entire water sector including hydropower, water supply and sanitation, irrigation, and overall water resources management. Briscoe's research observed that there is a global transitioning of the financing model whereby governments alone are not solely responsible for financing water infrastructure development, but also the involvement of the private sector plays an important role in financing water infrastructure. Consequently, there have been radical changes in the relative proportion of private and public spending on water infrastructure, as well as dramatic improvements in the investment and operation of water infrastructure associated with the realisation of major positive environmental impacts. Thus Briscoe's (1999) observation is similar to Ruiters' (2013) view that the provision of water infrastructure financing promotes water provision for socio-economic development and environmental benefits. On the contrary, the findings of this research indicate that water asset financing is not statistically related to the provision of water in South Africa. Briscoe's findings could be as a result of his target population since his research focused on several developing countries whereas this research focused mainly in South Africa. Furthermore, his research specifically focused more on the entire water sector including hydropower, water supply and sanitation, irrigation and overall water resources management. Whereas this research focused on water provision for basic

domestic use. In contrast, other scholars argue that apart from lack of water infrastructure financing, there are other factors that could impede the provision of water.

The research by Allen and Pyke (2013), for instance, was conducted in England and Wales, focusing on the use of a financial a model of leveraged debt made possible through the predictable nature of revenue streams captured from households who have no choice over their water supplier or the amount that they have to pay. The research by Allen and Pyke (2013) observed the emergence of a skewed distribution model of financialised infrastructure in the household water sector, which benefited investors more than the customers. Although Allen and Pyke's research focused on financial models which would ensure that water is provided to consumers in England and Wales, which are developed counties. They were unable to focus on the impact of water infrastructure financing and water provision in the context of South Africa as a developing country, which is the goal achieved by this research. Furthermore, the hydrological climate differs in that South Africa is a semi-arid country while England and Wales have abundant rainfall per annum. Therefore, Allen and Pyke's (2013) research observed that although there may be water infrastructure financing available, however, the existing models for financing of water infrastructure may not prove to be ineffective for adequate water provision especially in developing countries. This observation therefore agrees with the findings of this research where water asset financing proved to have no statistical significance on water provision in South Africa.

Badu et al. (2012) conducted research on the barriers to the innovative financing of water infrastructure in Ghana. Ghana's infrastructure deficit, resulting from the government's inability to finance current infrastructure demands, called for the need to explore potential obstacles and strategic issues underpinning innovative financing (IF) of infrastructure in Ghana. Thus, Badu et al. (2012) observed that there are other factors that impede water provision other than the actual financing, resulting in failure by government to provide water infrastructure in Ghana. Thus, investment capacity; implementation and revenue mobilisation, were identified by Badu et al. (2013) as key challenges responsible for failure in implementing the innovative financing of infrastructure. Although Badu et al. (2012) focused on Ghana as a target country, this research focused on the South African context. Furthermore, Badu et al. (2012) used

structured interviews and a survey questionnaire to gather data from experienced project implementation agencies for their research, which is different from the methodology followed for this research which used regression statistical analysis. In spite of the differences between both researches, Badu et al.'s (2013) research proved that even though financing infrastructure is possible, it could be hindered by other inherent factors that could ultimately impede provision of water to the public. This view corroborates with the statistical findings of this research which indicates that water asset financing as a single independent variable does not have a statistically significant impact on water provision. Therefore, in spite of the availability of water infrastructure financing, factors such as poor-investment capacity, poor implementation and lack of revenue mobilisation could impede the provision of water.

The research conducted by Chan and Ameyaw (2013) is similar to this research in that it looked at the investment needs for the water supply sector in Ghana, while this research investigated whether water infrastructure financing does contribute to water supply in the context of South Africa. Chan and Ameyaw's (2013) research revealed that although the PPP management contract exists between the local government and the private sector, the contract lacked a risk allocation option, which is one of the factors that constrained the development and implementation of projects in the water sector. This observation is different from the findings of this research, which may be attributable to that Chan and Ameyaw's research approach adopted an integrated multi-stage critical review of relevant related literature and case studies. Their research was further informed by the authors' experience in the sector and knowledge of PPPs. Analysis of data from different sources, provided historical and contemporary approaches to water management practice in Ghana using both approaches. In contrast, this research adopted parametric statistics, the multiple regression analysis to test the relationship between water infrastructure finance and water provision. Both researches looked at the relationship between water infrastructure financing and water supply. However, Chan and Ameyaw's (2013) research also focuses on the challenges associated with the involvement of the PPPs between the local government and the private sector in Ghana, which led to poor performance of the water sector in Ghana. In contrast, this research aimed to determine whether water infrastructure financing does promote water availability to consumers. Thus, Chan and Ameyaw's (2013) research concurs with Badu et al.'s (2012) research that the impediment of

water supply could not necessarily result from the lack of water infrastructure financing, but it could be due to other factors such as lack of effective regulation and governance. This perception supports the statistical findings of this research which indicate that water asset financing as a single independent variable does not have a statistically significant impact on water provision. Therefore, whilst various researchers agree that infrastructure financing is fundamental for sustainable water provision (Briscoe, 1999; Akhmouch, 2012; Ruiters, 2013), this observation is contradicted by various researchers, including this research, that water asset financing may not have a direct statistical contribution to water provision as there may be other factors such as financial models and policy reform, regulation, governance and accountability which could negatively affect sustainable water provision (Badu et al., 2012; Allen & Pyke, 2013; Chan & Ameyaw; 2013).

9.4.2 Discussion of findings from the statistical analysis in support of research question 2

Could governance impact on water provision?

Table 9.1 also indicate that the independent variable governance effectiveness (Govt. Effect) is not statistically significant since the model indicates that the p-value is 0.09527 which is more than the stated research significance maximum level of 0.05. Thus the governance effectiveness (Govt. Effect) does not have a significant statistical relationship with water provision.

Thus, effective governance proved to be not statistically significant to water provision, which implies that even in the presence of good governance, there may be other factors which could impede on water provision.

Table 9.1 also indicate that the independent variable governance effectiveness (Govt. Effect) is not statistically significant since the model indicates that the *P*-value is 0.09527 which is more than the stated research significance maximum level of 0.05. Thus governance effectiveness (Govt. Effect) does not have a significant statistical relationship with water provision. Meaning that there are may be other factors that impede on the effective governance of water in South Africa.

This research outcome is in accordance with a research conducted by Jiménez and Pérez-Foguet (2010) who analysed key challenges of water governance in the rural water supply in Tanzania. In their findings, poor quality of water services; unsustainable infrastructure; difficulties for targeting the poor; and poor internal information systems were identified as some of the factors that influence the governance of rural water services in Tanzania. Jiménez and Pérez-Foguet's (2010) findings could be attributed to the fact that Tanzania was used as a case study, while this research focused on South Africa as a target population for the research. Furthermore, while Jiménez and Pérez-Foguet focused on the analysis based on a combination of the relevant literature review, extensive fieldwork and action research case studies were carried out between 2005 and 2009. On the contrary, this research focused on the archival secondary data for South Africa between 1994 and 2014, following a parametric statistics and the multiple regression analysis to test the relationship between effective water governance and water provision. Despite the different methodological approached by both researches, they agree that there are other factors that could impede on effective water governance, thus impacting on water provision negatively.

In Tanzania's largest city, Dar es Salaam, the water supply does not meet the needs of the community. In response, people adopt multiple strategies to secure adequate water for their daily requirements. As a result, Rugemalila and Gibbs (2015) conducted a research on urban water governance failure and local strategies for overcoming water shortages in Tanzania, Dar es Salaam. Their goal was two-fold, to investigate the causes of urban water failure, and to examine the full range of strategies employed by the local community to overcome water shortages. Rugemalila and Gibbs' (2015) research found that failing urban infrastructure and rapid urbanisation placed additional pressure on the water supply, but they further argued that water governance failure is the primary cause of water shortages in Dar es Salaam. These findings are contradictory to the finding of this research which points that governance effectiveness (Govt. Effect) does not have a statistically significant relationship with water provision; meaning that there may be other factors that impede on the effective governance of water in South Africa. The differences from both researches could be attributed to different methodologies followed in both researches. For instance, Rugemalila and Gibbs's (2015) research was conducted in Dar es Salaam, Tanzania; while this

research targeted the entire South Africa. Furthermore, Rugemalila and Gibbs (2015) drew the primary information from household surveys and key informant interviews in Temeke, one of the city's three municipalities. On the contrary, this research focused on the archival secondary data for South Africa between 1994 and 2014, following parametric statistics and the multiple regression analyses to test the relationship between effective water governance and water provision. Therefore, governance may or may not impact on effective water provision, depending on the context of the target population under research.

Pahl-Wostl et al. (2013) also recognised that the missing links in the trajectories of policy development are largely responsible for relative ineffectiveness of global water governance. Pahl-Wostl et al.'s 2013b research found that there are three important policy arenas in global water governance, namely, the effort to address access to water and sanitation through the Millennium Development Goals; the controversy over large dams; and the links between climate change and water resources management which were identified as the missing link in the trajectories of policy development for global water governance. Their findings could be attributable to that they followed an exploratory analysis to test these categories while considering the successes and failures in each domain in order to identify implications and to recommend improvements for more effective and legitimate action. Conversely, this research followed parametric statistics and the multiple regression analyses to test the relationship between effective water governance and water provision. This research revealed that governance effectiveness (Govt. Effect) does not have a statistically significant relationship with water provision.

Dellapenna et al. (2013) also undertook a research focusing on the future of global water governance. In their research, Dellapenna et al. (2013) recognised that global water problems are likely to increase severity of water shortages if water governance reform does not occur. As a result, Dellapenna et al.'s (2013) research found that the nature of water problems calls for structural changes which could be used by social movements and networks to mobilise policy entrepreneurs and directional leaders. Thus, water governance reform achieved through social movements and networks is essential is a necessary part of effective water governance, thus promoting the provision of water. This view is different from the outcome of this research which

identified that governance effectiveness (Govt. Effect) does not have a statistically significant relationship with water provision and that there are other factors which could impede water provision. These findings are attributed to the research methodology and target population for the research which was the global population. In contrast, this research focused on the entire South Africa as the target population. Furthermore, Dellapenna et al. (2013) used storylines of possible water futures which were derived from existing scenarios in which the performance by global water governance is discussed. Conversely, this research employed a parametric statistics and the multiple regression analysis to test the relationship between effective water governance and water provision in South Africa. Therefore, both researches have a contradicting view regarding the relationship between effective governance and water provision.

Peloso (2014) undertook a research on the access and governance to supplying water in peri-urban Ashaiman in Ghana. The aim of this research was to understand other dimensions of how populations are served when they are not adequately reached by formal networks; as well as to explore the potential for participatory water governance, interrogate policy and scholarly literature that advocate for a more inclusive water governance which is key towards service extension and empowerment in Ashaiman, Ghana. His research found that a diversity of strategies for is necessary for allowing peri-urban dwellers to cope with water insecurities. Furthermore, mainstream approaches to participatory water governance may be at odds with local institutions operating within Ashaiman. On the contrary, this research determined that governance effectiveness does not have a statistically significant relationship with water provision, and that there are other factors which could impede water provision in South Africa. Peloso's findings could differ from the findings of this research as a result of the different target country Ghana, Ashaiman and the research methodology based on fieldwork which involved examining the myriad of mediums and networks through which water is accessed, particularly beyond the municipal water system. In addition, participation in water governance was assessed in terms of their experience and expression by the peri-urban poor. On the contrary, this research employed parametric statistics and the multiple regression analyses to test the relationship between effective water governance and water provision in South Africa. Therefore, Peloso's research identified the importance of inclusive water governance and policy reform

which are key towards service extension and empowerment in Ashaiman, Ghana. It is contradictory to the findings of this research in which that governance effectiveness proved not to have a statistically significant relationship with water provision.

The observation made in this research confirms recent concerns raised by policy makers and scholarly communities about the challenges associated with governance processes (Pahl-Wostl et al., 2013b; Lynch, 2012; Gupta et al., 2013). These challenges are particularly associated with poor governance which, in turn, impedes on the effective provision of water.

9.4.3 Discussion of findings from the statistical analysis in support of research question 3

How does accountability impact on water provision?

The results on Table 9.1 indicate that the p-value for accountability is 0.00342 which is less than the stated research significance maximum level of 0.05, thus very significant. This implies that the relationship between accountability and water provision is statistically significant. Meaning that where there is accountability for water services, water provision is likely to be effective.

Bain et al. (2012) conducted a case study research in five countries namely, Ethiopia, Nicaragua, Nigeria, Tajikistan and Jordan where the accounting of water quality in monitoring access to safe drinking water as part of the MDGs was conducted. Their research determined how water source quality data affected the assessments of progress towards the 2015 MDG target on the access to safe drinking water. Bain et al. (2012) found that taking account of data on water source quality provided substantially reduced estimates of the percentage of the population with access to safe drinking water in 2008 in four of the five studied countries, with only a slight reduction in Jordan. Furthermore, microbial contamination was more common than chemical contamination. Thus, monitoring drinking-water supplies by recording access to water sources and their safety as a means of accounting for access to water source and safety for use, led to substantial overestimates of the population with access to safe drinking water and progress made towards the 2015 MDG target. This

implies that monitoring of drinking water serves as an accountability tool for progress of access to safe drinking water. This view is consistent with the outcome of this research which revealed that where there is accountability for water services, water provision is likely to occur effectively. Although both research agree on the principle of effective water provision resulting from effective accountability, they differ in their methodological approaches. For instance, Bain's (2012) research followed a case study approach in which data from five countries were used to determine whether drinking-water sources complied with the World Health Organisation's water quality guidelines on microbial contamination in 2004 and 2005, using a Rapid Assessment of Drinking-Water Quality. The data were used to adjust estimates of the proportion of the population with access to safe drinking water at the MDG baseline in 1990 and in 2008. Alternatively, this research employed quantitative data of the entire South Africa for the period from 1994 to 2014 from secondary sources. The data were subjected to parametric statistics and the multiple regression analyses to test the relationship between accountability and water provision in South Africa.

Water accounts capture the value of water resources and its use within the economy and they complement the National Accounts. Setlhogile et al. (2016) undertook a rearch which focused on the Economic accounting of water in Botswana. Botswana developed water accounts for 2010/11 to 2014/15 using the UN'sStandard System of Environmental Economic Accounting for water (SEEA-water). Setlhogile et al.'s (2016) research found that the water accounts results show that water abstraction and consumption have been largely stable since 2010/11 despite population and economic growth, which could result from a combination of water sector reforms and drought conditions in south-eastern Botswana. Therefore, while public attention focuses mostly on water service providers, self-providers (mines and the agricultural sector) account for more than 50% of total water abstracted from the environment of water, demonstrating the need to pay more attention to self-providers in IWRM implementation. Therefore, due to monitoring of the trends of water use, public servants are able to account for the availability and provision of water. The water use accounts results show that water abstraction and consumption have been largely stable since 2010/11 despite population and economic growth in Botswana. The per-capita water consumption proved to have decreased over time; while this may indicate that people conserve water, it may also point at delivery problems associated with

water sector reforms. Therefore, these use of the SEEA water accounts for monitoring and linking water use efficiency with water account ensured an efficient water use by various sectors in Botswana. This means that where there is accountability for water, provision is possible, which concurs with the outcome of this research which demonstrates a positive statistical relationship between accountability and water provision in South Africa. Although both research agree on the principle of the impact of accountability of water provision, they both differ with regards to their methodological approaches. For instance, Setlhogile et al. (2016) focused on the physical water flow accounts of Botswana for the period 2010/11–2014/15 using the UN's Standard System of Environmental Economic Accounting for water (SEEA-water) as well as on the policy implications for development planning and water resource management through the use of policy indicators. Conversely, this research employed quantitative data of the entire South Africa for the period from 1994 to 2014 from secondary sources. This data were subjected to parametric statistics and the multiple regression analyses to test the relationship between accountability and water provision in South Africa.

Wild (2015) conducted research which provides insights into the perceived barriers and resistance to water reporting by major corporates and large Public Benefit Entities in Australia and New Zealand, with the aim of filling a gap in water-focused accounting research. In his research, Wild (2015) found that while the incidence and volume of water reporting in the sample group increased over the period of years (2009-2014) under research, this had not led to increased overall quality of the information reported. Entities operating in geographical areas with a central or regional regulatory requirement for reporting water-related information indicated a much higher incidence of reporting than entities in areas where governments did not mandate such reporting. Most organisations will respond positively only to ‘hard’ coercive measures such as water costing measures and mandated and audited reporting requirements, backed by punitive outcomes for compliance failure. Entities operating in high volume water use industries, or in low water-access regions, had a higher incidence, as well as higher volume, of water reporting. Increased volume of reporting was found in organisations subject to adverse water related publicity over negative environmental actions in the last 5-year period. Thus, the reporting of water use as an accountability initiative has improved over the years and it was motivated by the need to comply with

the audited reporting requirements which are backed up by punitive outcomes for failure to comply. Therefore, legislative and regulatory requirements play an important role in enforcing water accountability thereby promoting equitable water allocation and water use efficiency. This observation is consistent with the finding of this research which asserts that there is a statistical relationship between water accountability and water use. Although both researches agree on the relationship between water accountability and water provision, both researchers differ in their methodology approaches.

For example, Wild (2015) analysed a stratified sample of major Australian and New Zealand listed profit and public entities, based on size, sector, industry type and water use activity, and a third group of indigenous Māori-based organisations. The analysis involved two stages of research, where the first stage involved the quantitative and qualitative data capture and analysis of the published annual reports and other publicly available information of these target groups, for the years 2009 and 2014. The second stage of the research implemented a randomised online survey of relevant decision makers in the sample group, in order to elicit attitudes towards water use and motivations for water reporting. In contrast, this reaserch employed quantitative data of the entire South Africa for the period from 1994 to 2014 from secondary sources. The data were subjected to a parametric statistics and the multiple regression analysis to test the relationship between accountability and water provision in South Africa.

About 58% of inhabitants of sub-Saharan Africa, including Cameroon, have no access to potable water. The water sector in Cameroon has undergone restructuring in the wake of public-sector reforms and privatisation. As a result, Fonjong and Fokum (2017) examined the extent to which privatisation of water management has impacted on the water crisis in peri-urban areas in Cameroo. The United Nations Millennium Development Goal of reducing by half the proportion of people without access to portable water by 2015 and on the neoliberal argument for the privatisation of public goods formed the basis of their work in order to ensure accountability and effective provision of water. Their findings suggest that privatisation of the water sector has not improved the water problems of peri-urban inhabitants. Inhabitants are experiencing water shortages, rationing, poor coverage, poor accountability and high pricing, as investments in infrastructure lag behind the rising demand for the utility. In the

prevailing circumstances, the public–private partnership presents a possible alternative for Cameroon. Fonjong and Fokum's (2017) findings concur with the findings of this research which declares that there is a statistical relationship between water accountability and water use. Though both researches agree in the relationship between water accountability and water provision, they differ in their methodology approaches. While Fonjong and Fokum (2017) used primary data originating from interviews conducted among local inhabitants and public and water authorities of five purposively selected municipalities; this research, on the contrary, employed secondary quantitative data of the entire South Africa for the period from 1994 to 2014 which are available on a public domain. The data were then subjected to a parametric statistics and the multiple regression analysis to test the relationship between accountability and water provision in South Africa. Therefore, both researches agree that where there is accountability, there is also adequate and effective provision of water to consumers.

According to Georgiadou et al. (2014), Transparency and Accountability (TandA) interventions are emergent social technologies in middle and low-income countries, which bring citizen sensors, mobile communications, geo-browsers and social organisation together in order to raise public awareness on the extent of governance deficits, and monitor government's failure to act. This brings a question as to whether citizen sensors radically can increase the transparency of the state, or are changes brought about by TandA interventions more likely to be efficient. As a result, Georgiadou et al. (2014) conducted a research on transparency and accountability interventions on the mobile geoweb. From their research, they found that there are two elements at the interface between supply and demand that seem crucial for designers of TandA interventions, namely, accountability-relevant data and extreme publics. Thus, effective accountability for water supply and demand is important to have relevant data on accountability which will ensure effective accountability for water provision where needed, thereby occupying the communication space between the government and citizens. Therefore, effective accountability for water promotes water provision to the public. The findings of Georgiadou et al.'s (2014) research are in accord with the findings of this research which assert that there is a statistical relationship between water accountability and water use. Although both researches agree on their observations, they both differ in their methodological approaches in that,

Georgiadou et al. (2014) conducted a literature reviewed on transparency policies and described their drivers, characteristics and supply–demand dynamics. They also deliberated on promising cases of TandA interventions in East Africa. On the contrary, this research employed quantitative data of the entire South Africa for the period from 1994 to 2014 from secondary sources. The data were subjected to a parametric statistics and the multiple regression analysis to test the relationship between accountability and water provision in South Africa.

Although a number of researches agree on the view that accountability for water services is necessary for effective water provision, there are scholars who have a different view about the relationship between accountability and water provision. For instance, does providing citizens with information compensate for unreliable public services? This is a question that Kumar et al. (2017) and other scholars continue to ask. As a result they undertook research on transparency fixes for Local Public Services in Bangalore's Water Sector, the capital of India's southern Karnataka state. The implementers expected that increasing service predictability would reduce coping costs, increase transparency and improve state-citizen relations. However, Kumar et al. (2017) detected no impacts on household welfare or state-citizen relations. Thus non-cooperation by street-level bureaucrats charged with supplying water timing information undermined the programme’s viability. These findings suggest that frontline workers that drive experimental findings could impede on effective reporting and accountability for water availability even though the information exists. Thus even though accountability exists, the effector of it may impede water provision where it is required. This observation is contradictory to the findings of this research which assert that there is a statistical significant relationship between accountability and water provision in South Africa. The difference in findings for both researches could be credited to their different methodological approaches. For example, in their research, Kumar et al. (2017) presented a field-experimental evaluation of a programme that provided households with advance notification of intermittently provided piped water in Bangalore, India. On the contrary, this research employed quantitative data of the entire South Africa for the period from 1994 to 2014 from secondary sources. The data were subjected to a parametric statistics and the multiple regression analysis to test the relationship between accountability and water provision in South Africa.

9.4.4 Discussion of control variables from the analyses of research questions 1 – 3

According to the Worldwide Governance Indicators undertaken by the World Bank, governance is expressed through various dimensions such as Voice and Accountability, Absence of Violence, Government Effectiveness, Regulatory Quality and Control of Corruption which this statistical analysis focused on (Kaufmann et al., 2009).

Corruption

In contrast, corruption was also tested for statistical significance in Table 9.1 and it proved to be statistically significant since the *P*-value was 0.010 which is less that the stated research significance maximum level of 0.05.

Corruption has been identified as one of the major problems that has a negative impact on the socio-economic development of many nations. For instance, in Nigeria, corruption proved to be prevalent in all sectors of the economy, including the Public Service. As a result, Kayode et al. (2013) were motivated to undertake a case study on exposing the effect of corruption on the delivery of essential services in education, health, water, electricity and other infrastructure facilities by the Nigerian Public Service. In their findings, Kayode et al. (2013) observed that corruption in the Public Service is a major impediment to effective service delivery to the Nigerian public, including water provision. Considering the adoption of the Principal-Agent theoretical framework, Kayode et al. (2013) argue that due to the privileged position of the Public Servants (Agents) to public resources and information, they tend to abuse these privileges to the detriments of the Principals (Nigerian citizens). This observation corroborates the findings of this research where corruption proved to be statistically significant to water provision. This means that where there are no control measures against corruption in government, effective water provision to the South African public could be hampered. In spite of the similar findings by both researches. They also employed data from secondary sources. However, Kayode et al. (2013) followed a qualitative data analysis of the Nigerian public sector to determine if there is a symbiotic relationship between corruption in the Public Service and effective service delivery of education, health, water, electricity and other infrastructure. On the

contrary, this research employed quantitative data from secondary sources which were subjected to a parametric statistics and the multiple regression analysis to test the relationship between corruption in government and water provision in South Africa.

Nguyen et al. (2017) conducted a national survey on local governance, corruption and public service quality in Vietnam. Their research examined whether higher levels of transparency, accountability and participation have a statistically significant association with corruption and whether corruption is highly correlated with lower public service quality in the context of Vietnam's transition economy. Nguyen et al. (2017) found that a higher level of transparency, participation and accountability is associated with a lower level of corruption, and that corruption is negatively associated with public service quality. Their research suggests that fostering accountability in citizens and non-state sectors and promotion of genuine participation from these stakeholders are critical for the future anti-corruption agenda (Nguyen et al., 2017). Thus, their observations also corroborate with the findings of this research where corruption proved to be statistically significant to water provision, meaning that where there is prevalent corruption in government, it could impede effective water provision to South African citizens. Using individual-level survey data from Vietnam Provincial Governance and Public Administration Performance Index (PAPI), Nguyen et al.'s (2017) research employed an Ordered Probit model to test whether greater transparency, accountability and participation are associated with lower levels of corruption. Furthermore, secondary data were used to test the relationship between corruption and quality of public services particularly in healthcare and primary education. Conversely, this research employed quantitative data from secondary sources which were subjected to a parametric statistics and the multiple regression analysis to test the the relationship between corruption in government and water provision to South Africans. Therefore, whether corruption enhances efficiency of service provision is highly debatable in developing countries, nevertheless, both researches concur that corruption significantly decreases the quality of the public service and that improving local governance helps reduce corruption.

Conversely, there is an interesting observation by a number of scholars that the effects of corruption on socio-economic growth seem to differ significantly across countries. For instance, in large and regionally diverse countries such as China and India, extensive corruption has not slowed down growth; on the contrary, in many African

and South American countries it seems that corrupt officials severely retard growth. Research conducted by Allen et al. (2015) aimed to determine whether corruption is associated with the provision of government services and goods. They observed that as a result of an agency problem, corruption occurs and local officials set higher than social optimal fees as bribes. Although central government could mitigate the agency problem by paying for performance financed by tax revenues, however, governments are often budget-constrained and they have limited power in controlling corruption with such payment schemes. One possibility is to use the law to try to rule out corruption, yet, such attempts often fail. Hence Allen et al. (2015) contend that in order to combat corruption, the introduction of competition between officials is an effective solution. Having multiple officials providing the same service or goods, a competitive fee is determined and the malicious effects of corruption are minimised. Moreover, the cost of implementing the optimal payment scheme by the central government is also minimised. Thus this theory is consistent with the view that some countries are growing at faster rates despite corruption while others are severely damaged by it. This proves that effective service provision (including water) amidst corruption is possible provided competition is promoted among several public service providers. This theory is contradictory to the findings of this research which contends that corruption impedes effective water provision. The contradiction between these researches could be attributed to different methodological approaches. For instance, Allen et al.'s (2015) research employed a review of related work and present empirical evidence on corruption, governments' taxing ability and economic growth of several countries in China, India, Africa and South America. It also used a model of corruption based on standard models of industrial organisation and market power. In contrast, this research employed quantitative data from secondary sources which were subjected to a parametric statistics and the multiple regression analysis to test the relationship between corruption in government and water provision in South Africa. Therefore, depending on the level of socio-economic development and the context of the country, corruption may or may not impede effective water provision.

In Africa, corruption is a major source of slow development. While current research has focused on the causes and consequences of corruption at the macro-level, less effort has been made towards understanding the micro-foundation of corruption, as well as the mechanisms through which poverty may be related to corruption and

bribery which is what Justesen and Bjørnskov's (2014) research aimed to do. As a result, Justesen and Bjørnskov (2014) developed a model for the relationship between poverty and corruption which suggests that poor people are more likely to be victims of corrupt behaviour by local government officials. Their research confirmed that since poor people often rely heavily on services provided by governments and are therefore more likely to be met by demands for bribes in return for obtaining those services. Therefore, due to poverty, some people are more prone to corruption through the payment of bribes made to government officials. These findings imply that people are still able to get water and other public services in spite of the presence of corruption, which is contradictory to the outcome of this research which identified that corruption impedes effective water provision.

The difference in the findings of these researches could be attributable to different methodological approached followed by both researches. For instance, while Justesen and Bjørnskov's research focused on the relationship between poverty and corruption in Africa, this research focussed on the relationship between corruption in government and water provision in South Africa. Justesen and Bjørnskov's research used micro-level survey data from the Afrobarometer, where individuals were surveyed in different African countries. They employed a multilevel regressions analysis to estimate the effect of poverty on people's experience with paying bribes. This research, alternatively, used quantitative data from secondary sources which were subjected to a parametric statistics and the multiple regression analysis to test the relationship between corruption in government and water provision in South Africa. Thus corruption, through bribery, results in the provision of basic services such as water which is a necessity to the poor. This view is contradictory to the finding of this research, which argues that where there is prevalent corruption, there is ineffective water provision.

Regulation

Interestingly, the independent variable, regulation, proved to be statistically not significant when tested against water provision (Table 9.1). The *P*-value is 0.22307 for regulation, which is more than the the stated research significance maximum level of 0.05, meaning that the relationship between regulation and water provision is not significant.

Chng (2012) undertook research on regulatory mobilisation and service delivery which is at the verge of the regulatory state. Chng's research aimed to show how private actors (e.g. NGOs and local community groups) undertake "regulatory mobilisation" to influence the new rules of the service delivery and to deliver much-needed basic services to urban poor communities using Manila in the Philippines as a case study. His research revealed that since the privatisation of the Metropolitan Waterworks and Sewerage System in Manila, water access for the urban poor remained limited as privatised water utilities faced difficulties in extending service provision. As a result, in the context of an unpredictable regulatory landscape, unexpected collective action by organised urban poor communities and NGOs has taken place around obtaining water as a subsistence right. Thus, influencing the rules governing water provision and regulation, which may occasionally have an opposing impact on the policy sector, and influence formal regulatory frameworks depending on local and sectorial political context. This implies that although a collective action of mobilising poor communities and NGOs around water as a subsistence right may ensure water provision. The action may impact the policy and regulatory framework differently. This view corroborates the findings of this research which found regulation not to have a statistical relationship with water provision, meaning that even though water regulation may exist as a measure for effective governance, there are other peripheral factors which could impede on water provision such as collective governance by stakeholders. The findings of Chng's research could be attributable to the target population and country for the research, where the research specifically focused on Manila, the capital city of the Philippines. On the contrary, this research focused on the entire country of South Africa. Furthermore, while Chng's research focussed on the impact of collective governance of the poor communities and NGOs on effective water provision, this research focused more on the relationship of effective governance through regulation with water provision. Chng's research methodology was based on the extensive fieldwork carried out in the Philippines; this research employed a parametric statistics and the multiple regression analysis to test the relationship between effective regulation of water and water provision in South Africa.

Quintas-Soriano et al. (2014) agree that global water managers and policy makers are pressured with demands for limited and scarce water resources, particularly in semi-arid ecosystems. As a result, a landscape-scale analysis of the water regulation

service, from supply to social demand was undertake by Quintas-Soriano et al. (2014). Their research aimed to assess the impact that the water regulation service has in semi-arid ecosystems of the south-eastern Iberian Peninsula. Quintas-Soriano et al. (2014) found that some landscape units are able to maintain and conserve water regulation services when the volume of water supply is greater than the demand. Therefore, their research emphasised the importance of water regulation services for identifying social benefits, especially when the recharge water by aquifers and the water supply from reservoirs are greater than its consumption, thus providing practical information about integrated ecosystem service management and planning. This finding implies that the regulation of water supply has a positive influence towards ensuring sustainable monitoring, management and planning for water provision to the society. In contrast, this research looked at the impact of water regulation on water provision. The relationship of water regulation proved to be not statistically significant with water provision, meaning that where there is no regulation of the supply of ground water, water demands can exceed the supply making water not to be available for social use. This observation could be as a result of the target research, the Iberian Peninsula, whereas this research focused on South Africa. Although Quintas-Soriano et al. (2014) followed a comparative analysis between the supply-demand of ground water across different landscape units of Iberia, this research used a parametric statistics and the multiple regression analysis to test the relationship between effective regulation of all water resources and water provision in South Africa.

Berg (2013) conducted a research on the best practices in the regulation of the State-owned and municipal water utilities in developing countries. Berg's research found that water sector regulation has to be embedded in an adequate and consistent institutional framework in order to have a positive impact on performance. Thus, without significant changes in the supporting institutions, the standard tools of regulation will not be effective. Furthermore, sector regulation, by itself, is no guarantee of performance improvements in the drinking water supply and sanitation sector. Berg's findings corroborate the findings of this research which looked at the impact of water regulation on water provision and water regulation proved not to be a statistically significant relationship with water provision, meaning that there may be other factors which could impede effective water regulation, thus compromising the effectiveness of regulation

for effective water provision. In spite of the agreement between both researches, while Berg focused on a number of developing countries, this research targeted South Africa as a study area. Berg (2013) followed the case study and empirical analyses approach to survey the regulation of state-owned and municipal water utilities in developing countries. On the contrary, this research employed a parametric statistics and the multiple regression analysis to test the relationship between effective regulation of all water resources and water provision in South Africa.

Violence

The relationship between violence and water provision was also tested on regression model and Table 9.1 indicates that the *P*-value for violence is 0.01725 which is less than the stated research significance maximum level of 0.05, thus statistically significant. Thus, the relationship between violence and water provision proved to be statistically significant.

Ineffective water provision to water users could result in violent protests. As a result, the relationship between violence and water provision was also tested on regression model and Table 9.1 indicates that the p-value for violence is 0.01725 which is less than the stated research significance maximum level of 0.05, thus statistically significant. Thus the relationship between violence and water provision proved to be statistically significant, meaning that lack of adequate water provision breeds violent protests by the public.

A number of scholars agree with the outcome of this research where violent protests by members of the public proved to result from poor service provision by public servants. For instance, Netswera (2014) researched the underlying factors behind violent municipal service delivery protests in South Africa. Political violence is a historical occurrence in South Africa due to apartheid. In his research, Netswera (2014) analysed the escalation of service delivery protests and ascertained some of the underlying reasons for the mutual exchange of violent behaviour between protesting citizens and the state. From his research, Netswera (2014) found that the factors that shape the essence of violent protests include, but are not limited to, the culture of a long history of violent protest culture, low trust levels of politicians and the political system, class consciousness, the racial divide and corruption and a display of

lavishness by societal representatives in government. Netswera's findings corroborate the findings of this research which revealed that violence is a statistically significant relationship with inadequate water provision in South Africa. Although both researches agree in their observations, they differ with respect to their methodological approaches. For instance, Netswera (2014) followed a literature review of violent service delivery protests in South Africa between 2004 and 2011. Instead, this research used a regression model of secondary data for the period between 1994 and 2014, looking at the relationship between violence and water provision in South Africa. Thus both researches agree that over the past few years in South Africa, violence has been associated with poor service delivery protests, which often result in the loss of lives and damage to property.

According to Mkhabela (2014), soon after the ANC acquired the leadership of the South African Government, there has been a series of service delivery protests at the municipal level. A number of researches were conducted to understand the underlying cause of these protests and many researches concluded that the slow pace of delivering houses, electricity, water and sanitation to the local communities is responsible for service delivery protests. Yet, no research has elected to focus on the view of the employees of the municipalities to which the grievances are mostly directed, which was a goal achieved by a research undertaken by Mkhabela (2014). Thus, Mkhabela conducted a Doctoral Thesis on Governance and service delivery protest in Bitou Municipality, Plettenberg Bay, Western Cape Province, South Africa. The research uncovered a number of reasons that contribute to service delivery protests and government practices which fuel support or hinder service delivery. Mkhabela's findings support the findings of this research that violence is a statistically significant relationship with inadequate water provision in South Africa, meaning that poor service delivery and inconsistent government practices often lead to service delivery protests which turn out to be violent leading to property damage and loss of lives. Although both researches were conducted in South Africa, Mkhabela's research targeted mainly Bitou, Plattenberg Bay, Western Cape Province, looking at the provision of water and sanitation, waste removal, roads and electricity service delivery, while this research targeted the entire South Africa, focusing on water service provision only. In addition, Mkhabela's research adopted a qualitative research design that surveyed municipal managers, ordinary employees as well as community

members in Bitou Municipality; conversely, this research employed quantitative data from secondary sources which were subjected to a parametric statistics and the multiple regression analysis to test the relationship between violence and water provision to South Africans. Despite different methodological approaches followed in both researches, there is an agreement that poor governance and lack of effective service provision are some of the causes of violent service delivery protests in communities (Netswera, 2014; Mkhabela, 2014).

Bradshaw et al. (2016) undertook a research in which they examined police brutality in the light of violent service delivery protests within the context of the Nelson Mandela Bay Municipality (NMBM) in the Eastern Cape, South Africa. The research aimed at making a contribution towards the ongoing debate on violent service delivery protests in South Africa, particularly in NMBM where service delivery protests resulting from a lack of, or the slow pace of service delivery, corruption and cadre deployment, are characterised by violence. Their research revealed that police officers are not sufficiently trained to deal with a crowd during protests at the local government level. Thus, the confrontations that take place between protesters and the police frequently result in bloodshed, looting, throwing of stones, burning of tyres and the use of tear gas and stun grenades. Moreover, police brutality poses a threat to the available resources such as buildings, roads, schools, clinics and other public services. This implies that service delivery protests which are initially peaceful end up being violent because of the inability and lack of training by police officers to manage crowd. The use of police brutality as a means of confronting the protesters leads to bloodshed, retaliation, opportunistic crime, property damage and vandalism by some protesters, rendering the service delivery protests to be violent. Therefore, lack of, or the slow pace of service delivery, corruption and cadre deployment are not necessarily the main cause of violence during service delivery protests, however, the poor crowd management by the police force eventually leads to violence. This finding is contradictory to the outcome of this research which asserts that violence is a statistically significant relationship with inadequate water provision in South Africa, meaning that poor service delivery and inconsistent government practices often lead to service delivery protests which turn out to become violent leading to property damage and loss of lives. Bradshaw et al.'s (2016) findings may be largely attributed

to their methodological approach in that their research focused on Nelson Mandela Bay Municipality (NMBM) in the Eastern Cape, South Africa, while this research looked at the entire South Africa as a target population of the research. Their research employed a qualitative literature assessment method in which researchers examined the issues in question through the theoretical lens of the human needs theory. Conversely, this research employed quantitative data from secondary sources which were subjected to a parametric statistics and the multiple regression analysis to test the relationship between violence and water provision to South Africans, using Agency and Stewardship Theories as the basis. Hence both researches have different findings.

Akinloye Akinboade et al. (2012) undertook an analysis of citizen satisfaction with public service delivery in the Sedibeng district municipality in South Africa, which consists of three local municipalities, Lesedi, Emfuleni and Midvaal. Their research found that the respondents are most dissatisfied with roads maintenance, government efforts to create jobs, and reduce crime, rather than the provision of water, electricity and waste removal services. Therefore, there are other reasons for service delivery protests other that the provision of water, electricity and waste removal services. Consequently, violent protests can still occur for other reasons such as job creation, roads and the the municipality's efforts in cutting down on crime. This finding by Akinloye Akinboade et al. (2012) is inconsistent with the findings of this research wherein violence has a statistically significant relationship with inadequate water provision in South Africa, meaning that poor water service provision and inconsistent government practices often lead to service delivery protests which turn out to be violent. Although both researches were conducted in South Africa, the difference in their methodological approach could be the reasons for the different outcomes. For instance, in Akinloye Akinboade et al.'s (2012) research, sampling was carefully designed, following a spatial distribution of the population in the Sedibeng district municipality and the three local municipalities. A structured sample of 1,000 respondents was used for the research and descriptive and inferential statistics approaches were used. Their research focused on public service delivery in health care, housing, water, electricity, solid waste removal, community services or overall physical appearance of the community, cutting crimes and job creation. In contrast, this research employed quantitative data of the entire South Africa for the period from

1994 to 2014 from secondary sources. The data were subjected to a parametric statistics and the multiple regression analysis to test the relationship between violence and water provision in South Africa. Therefore, there may be other triggers of service delivery protests other than the provision of water to communities.

Voice

Similarly, the p-value for voice is 0.01977 which is less than the stated research significance maximum level of 0.05. Thus, the relationship between the voice and water provision proved to be statistically significant.

The present research by Nayak and Samanta (2014) examined the role of people's participation in public service delivery in East Midnapore district of West Bengal, India. In their research, Nayak and Samanta (2014) considered four dimensions of participation namely attending meetings, raising voice, lodging complaints, and making contributions. They found that participation in households' socioeconomic and political positions exerts significant impacts in public service delivery. However, there is likelihood of "elite capture" (where resources transferred for the benefit of the masses are usurped by a few, usually politically and /or economically powerful groups, at the expense of the less economically and/or politically influential groups) and clientelism (in which there is an exchange of goods and services for political support, often involving an implicit or explicit favour or advantage granted in return for something). It is a political system at the heart of which is an asymmetric relationship between groups of political actors described as patrons and clients and political parties in the delivery of public services. Nayak and Samanta's findings are consistent with the outcome of this research which asserts that the relationship between the voice and water provision proved to be statistically significant. Although both researches agree in their findings, their methodology approach differs. For instance, Nayak and Samanta's research specifically focused on East Midnapore district of West Bengal, India; while this research targeted the entire South Africa. Furthermore, Nayak and Samanta's research employed household level data of East Midnapore district to reach their research findings. On the contrary, this research employed quantitative data of the entire South Africa for the period from 1994 to 2014 from secondary sources. This data were subjected to a parametric statistics and the multiple

regression analysis to test the relationship between voice and water provision in South Africa.
Nevertheless, both researches concur on the view that people must raise their voice and make contributions during public meetings in order to realise effective service delivery.

Recent years have seen a growth in mobile applications and services in the water sector addressing some of the sector's governance challenges. However, the sustainability rate proves to be low as there is a lack of research on the real benefits derived from it. As a result, Hellström and Jacobson (2014) conducted research on the use of mobiles (cell phones) to improve water governance and transparency towards the community. They found that the benefits of using mobiles strengthened the consumer voice, improved service delivery, collected new and better data and reduced costs. However, they also observed that common challenges include lack of incentives to use the system, user costs, user privacy, absence of basic infrastructure, lack of responsiveness, and limited marketing. Hellström and Jacobson's findings concur with the findings of this research which asserts that there is a statistically significant relationship between the voice and water provision in South Africa. Even though both researches agree in their findings, they differ based on their methodology approaches. Hellström and Jacobson's research outcome could be attributable to an in-depth analysis of four cases conducted through interviews and field visits in order to understand the common benefits and challenges for increased and sustainable use of mobile applications in the provision of water services. Then again, this research employed quantitative secondary data of the entire South Africa for the period from 1994 to 2014 from various databases. The data were subjected to a parametric statistics and the multiple regression analysis to test the relationship between voice and water provision. Thus, there is an agreement from both researches that increased transparency and consumer voice is fundamental to promote accountability by responsible institutions to provide water and other services to community members.

Peixoto and Fox (2016) conducted research in which of 23 information and communications technology (ICT) platforms were used to project citizen voice to improve public service delivery through a conceptual framework. Their research discovered two roles played by ICT-enabled citizen voice, which are to inform upwards

accountability, and bolstering downwards accountability through either individual user feedback or collective civic action. This distinction between the ways in which ICT platforms mediate the relationship between citizens and service providers contribute towards public sector responsiveness, meaning that citizen voice, through ICT communication platforms, promoted effective service delivery, including water provision by local authorities. Such findings correspond with this research's finding which asserts that there is a statistically significant relationship between the voice and water provision in South Africa. Although both researches agree on the observed relationship between citizen voice and water provision, they differ with respect to their methodological approaches. For instance, Peixoto and Fox's research, used a meta-analysis, which focused on empirical researches of initiatives in the global South, highlighting both citizen uptake and the degree to which public service providers respond to expressions of citizen voice. Conversely, this research employed quantitative secondary data of the entire South Africa for the period from 1994 to 2014 from various databases. The data were subjected to a parametric statistics and the multiple regression analysis to test the relationship between voice and water provision. Nevertheless, both researches suggest that citizen voice play an important role towards promoting effective public service delivery, including the provision of water.

Fox (2015) also undertook a research on the empirical evidence of social accountability. His research revealed that an enabling environment for collective action coupled with a strengthened state capacity in order to respond to citizen voice is more promising. Thus, a synergic relationship of a joined state capacity with citizen voice plays a fundamental role in promoting effective social accountability and service delivery. Fox's findings are in agreement with the findings of this research, which declares that there is a statistically significant relationship between the voice and water provision in South Africa. Even though both suggest that citizen voice promotes water and other public service provision, both researches vary with regards to methodology. For instance, Fox's research employed field experiments involving strategic interventions based on optimistic assumptions about the power of information alone, both to motivate collective action and to influence the state. This research, on the contrary, employed quantitative secondary data of the entire South Africa for the period from 1994 to 2014 from various databases. The data were subjected to a parametric statistics and the multiple regression analysis to test the relationship

between voice and water provision. Despite the methodological differences, both researches concur on the relationship between citizen voice and effective water and other service provision.

There are contrary views by some scholars which show citizen voice does not directly lead to effective water provision. There are instances where water service provision is inadequate inspite of the expression of citizen voice requesting for improved services. For example, although a legal framework for public participation exists in South Africa, poor citizens have not to date been able to access basic public services, leading some to talk of a second democracy which is the political system as experienced by the poor. As a result, a case study on the use of citizen voice as an intervention for water service delivery was undertaken by Hemson and Buccus (2009) in rural Mbizana in the Eastern Cape, South Africa, where water services had been grossly inadequate and were worsening. The study found that in spite of the the citizen voice, disappointment were experienced by citizens because water service improvements had not been immediately realised. The crucial constraint to lack of improved water services was weak inter-level local government coordination, which is a higher-level problem that cannot be adequately addressed through a local civil society action of the citizen voice intervention. Therefore, this observation is contrary to the findings of this research which proved that there is a statistically significant relationship between the voice and water provision in South Africa. The contrasting views from both researches could be attributable to differences in their methodological approaches, For instance, in Hemson and Buccus's research, the research was conducted at a local level, in rural Mbizana, Eastern Cape, South Africa, while this research was conducted at a national level, focusing on the entire South Africa.

In their case research, Hemson and Buccus (2009) followed an action-research approach which involved local government, non-governmental organisations (NGOs), community leaders and community mobilisation to develop Water Services Scorecards, in rural Mbizana. Communities were facilitated to analyse their own water-related problems; to establish standards and to measure services against indicators adapted from national policy frameworks. Conversely, this research employed quantitative secondary data of the entire South Africa for the period from 1994 to 2014 from various databases. The data were subjected to a parametric statistics and the multiple regression analyses to test the relationship between voice

and water provision. Hence these researches differ in terms of their approach and findings, presenting a different perspective regarding the relationship between citizen voice and water provision.

9.4.5 Discussion of Findings from the Statistical Analysis in Support of Research Question 4

What role could water asset play in poverty alleviation and development in South Africa?

In testing for the relationship between water provision and poverty alleviation in South Africa, two analysis were conducted in Table 9.4 (Test 4A) and in Table 9.7 (Test 4 B). The first analysis appears in Table 9.4, which tested water provision per province in South Africa and incidence of poverty per province in South Africa – this was necessary to get to the grass-root of water provision and incidence of poverty at the grass-root. The second analysis appears in Table 9.7, which tested the relationship between water provision in South Africa at the national level and cereal production at the national level.

The findings from the analysis in Table 9.4 (Test 4A) indicate a significance value of 0.008, which is lower than the research alpha value of 0.05. Similarly, the findings from the analysis in Table 9.7 (Test 4B) show a significance value of 0.007. Therefore, findings from Table 9.4 means that there is a significant relationship between water provision and reduction in incidence of poverty in South Africa. In the same vein, findings from Table 9.7 means that there is a significant relationship between water provision and cereal production in South Africa. The above findings indicate that water availability promotes reduction in the level of incidence of poverty. It also means that water availability promotes cereal production, thus alleviating poverty particularly in the rural poor communities in South Africa.

The present water shortage continues to be one of the primary and more critical world issues in the future. Water availability and accessibility are the most significant necesseties for crop production, therefore in areas affected by water scarcity, it is crucial to address this issue. Mancosu et al. (2015) undertook a research focusing on future challenges for water scarcity and food production. Their research noted that there exists a relationship between the water possessions of a country and the

capacity for food production. As a result, climate change, increasing water scarcity and drought, and considerable competing for water use for irrigation are expected to occur between agribusiness and other sectors of the economy. In addition, the estimated increment of the global population growth rate could result in the inevitable increase of food demand with direct impact on farming water use in the future. Mancosu et al.'s (2015) findings resonate with the outcome of this research in which there is a statistically significant relationship between cereal production and water provision. Although both researches agree in terms of the principle of their findings, they vary with respect to their methodology. For instance, Mancosu et al. (2015) followed a review of current and future issues related to water scarcity in order to highlight the necessity of a more sustainable approach to water resource management. Their review involved several water-related issues, including virtual water trade, water availability and future demand scenarios. On the other hand, this research employed quantitative secondary data of the entire South Africa for the period from 1994 to 2014 from various databases. The data were subjected to a parametric statistics and the regression analysis to test the relationship between cereal production and water provision. Therefore, both researches agree that water provision has an impact on food and cereal production.

Drought is known to be a major cause of agricultural disaster, yet how it affects the vulnerability of staple cereal crops such as maize and wheat production in combination with several co-varying factors such as phenological phases, agro-climatic regions, soil texture, which remains unclear. As a result, a research conducted by Daryanto et al. (2016) on global synthesis of drought effects on maize and wheat production aimed to better characterise the effects of those co-varying factors with drought and to provide critical information on minimising yield loss. Their results show drought leads to yield reduction which varied with species. For instance, wheat had a lower yield reduction of 20.6% compared to maize which was 39.3% at approximately 40% water reduction. Maize proved to more sensitive to drought than wheat, particularly during the reproductive phase and equally sensitive in the dryland and non-dryland regions. This proves that drought leads to reduction of cereal production, depending on the species. These findings concur with the findings of this research which find that there is a statistically significant relationship between cereal production and water provision. Even though both researches concur on the impact of water availability on cereal

production, they differ in terms of their methodology. Daryanto et al.'s (2016) research used a data synthesis approach where the collected data from peer-reviewed publications between 1980 and 2015, which examined maize and wheat yield responses to drought using field experiments, were used. They further performed unweighted analyses using the log response ratio to calculate the bootstrapped confidence limits of yield responses and calculated drought sensitivities with regards to those co-varying factors. On the other hand, this research employed quantitative secondary data of the entire South Africa for the period from 1994 to 2014 from various databases. The data were subjected to a parametric statistics and the regression analysis to test the relationship between cereal production and water provision. Therefore, both researches agree that water provision has an impact on cereal production.

Many scholars agree that climate change can reduce crop yields and thereby threaten food security. According to Meng et al. (2016), the current measures used to adapt to climate change involve avoiding crops yield decrease, however, the limitations of such measures due to water and other resources scarcity have not been well understood. Hence, Meng et al. (2016) undertook a research on the sensitivity of maize to water scarcity due to climate change. Their research found that modern, longer-maturing maize varieties have extended the growing period by an average of 8 days and have significantly offset the negative impacts of climate change on yield. However, the sensitivity of maize production to water has increased: maize yield across the CMB was 5% lower with rain fed than with irrigated maize in the 1980s and was 10% lower in the 2000s because of both warming and the increased requirement for water by the longer-maturing varieties. Of the maize area in China, 40% now fails to receive the precipitation required to attain the full yield potential. Their findings are in agreement with the findings of this research which found that there is a statistically significant relationship between cereal production and water provision in South Africa. While both researches agree in this aspect, they differ in terms of their methodology. Meng et al. (2016) quantified how the sensitivity of maize to water availability has increased because of the shift toward longer-maturing varieties during the last three decades in the Chinese Maize Belt (CMB). On the other hand, this research employed quantitative secondary data of the entire South Africa for the period from 1994 to 2014 from various databases. The data were subjected to parametric statistics and the regression

analysis to test the relationship between cereal production and water provision. Similarly, both researches agree that water provision has an impact on cereal production.

Not all researchers agree on the view that water availability impacts on cereal production. While many regions are faced with the adverse impact of climate change including floods and drought among others, notably, sub-Saharan Africa (SSA) is pressed with water stress and food insecurity challenges which are projected to grow. Small-scale, rainfed agriculture is the main livelihood source in arid and semi-arid areas of SSA. However, due to climate change, sub-Saharan Africa, which comprises 43% arid and semi-arid areas is projected to have increased droughts in future. Since rainfed agriculture constitutes more than 95 % of agricultural land use, water scarcity is a major limitation to production. Thus staple cereal crop production, will have to adapt to water scarcity and improved water productivity (output per water input) to meet food requirements. In order to achieve this goal, Hadebe et al. (2017) conducted a research on drought tolerance and water use of cereal crops in SSA, focusing on Sorghum as a staple crop. Hadebe et al. 2017 found that Sorghum uniquely fits production in such arid and semi-arid regions, due to its high and stable water-use efficiency, drought and heat tolerance, high germplasm variability, comparative nutritional value and existing food value chain in SSA. However, sorghum is socio-economically and geographically underutilised in parts of SSA. Their research indicates that depending on the type of cereal being cultivated, some cereal crops are more resilient to drought over other cereals and sorghum proves to withstand the adversities of drought, resulting in increased cereal production. This observation proves to contradict the outcome of this research which found that there is a statistically significant relationship between cereal production and water provision in South Africa. The difference in outcome between the researches could be attributable to different methodological approaches. Hadebe et al. (2017) used an inclusion and promotion of drought-tolerant cereal crops in arid and semi-arid agro-ecological zones of SSA where water scarcity is a major limitation to cereal production. On the other hand, this research employed quantitative secondary data of South Africa for the period from 1994 to 2014 from various databases. The data were used to conduct parametric statistics and the regression analyses to test the relationship between cereal production and water provision. Therefore, the use of Sorghum in arid and semi-

arid areas of SSA, can improve water productivity and food security especially among subsistence farmers.

9.5 Conclusion

This chapter tested that water asset plays a crucial role in poverty alleviation In South Africa. Two analysis were used where the first analysis tested water provision per province in South Africa and incidences of poverty at grass root level; and the second analysis which tested the relationship between water provision in South Africa at the national level and cereal production at the national level. The findings of the analyses therefore indicated that there is a significant relationship between water provision and reduction in incidence of poverty in South Africa. In the same vein, findings of the second analysis indicated that water availability promotes the reduction in the level of incidence of poverty. Thus water availability promotes cereal production which alleviates poverty particularly in the rural poor communities in South Africa. Therefore, the present water shortage continues to be one of the critical issues in the world in future and water availability and accessibility are crucial requirements for crop production in areas affected by water scarcity. Therefore, it is crucial to address this issue in semi-arid countries such as South Africa. The next chapter presents a summary of the findings from the statistical analysis and indicates how these findings have met the objectives of this research; it also presents the contribution of the research to the body of academic knowledge, it presents recommendations and it proposes the suitable framework.

CHAPTER 10

CONCLUSION AND RECOMMENDATIONS

10.1 Introduction

This chapter presents a summary of the findings from the statistical analysis of Chapter 8 and indicates how these findings have met the objectives of this research. This chapter also presents the contribution of the research to the body of academic knowledge by, firstly, answering research question 4 (objective 4) by proposing a framework for enhancing water infrastructure financing and water provision; secondly, by making use of the framework, further research recommendations (with a suggested model) have been provided as a starting point for further research; and thirdly, the researcher proposed on how to improve water provision to members of the public in rural South Africa. All these aspects are addressed in the subsequent sections of this chapter.

10.2 Summary of findings

This research set up five (5) research objectives as listed below:

i. To evaluate the relationship between water infrastructure financing and water provision.

ii. To examine whether there is a relationship between financial governance and water provision.

iii. To assess the relationship between financial accountability and water provision.

iv. To examine how water provision relates to rural poverty alleviation.

v. To propose a framework for enhancing water infrastructure financing and water provision.

The research achieved the objectives as follows:

10.2.1 Objective 1: To evaluate the relationship between water infrastructure financing and water provision

The first objective of this research was to evaluate the relationship between water infrastructure financing and water provision. In order to achieve this objective, the researcher first reviewed relevant literature covering the relationship between water infrastructure financing and water provision. Various mixed findings were identified from the literature, some with positive findings (Ruiters, 2013; Akhmouch, 2012; Briscoe, 1999), others with negative or no relationship (Badu et al., 2012; Allen and Pyke, 2013; Chan & Ameyaw, 2013). It then became pertinent to examine this relationship within the South African context.

The researcher proceeded to collect water infrastructure finance and water provision data from the archives of the TCTA which is the custodian of water infrastructure for the Republic of South Africa. These variables were then analysed to establish a relationship using the regression statistics, where the alpha (α) level of acceptance was set at 0.05 (5%).

From the statistical analyses results, although a relationship does exist between water asset financing and water provision, however, water asset financing proved to be statistically insignificant at a *P* value = 0.06503 (7%) which is more than the stated research alpha (α) level of 0.05. This means that the relationship between water asset financing and water provision is weak, indicating that water asset financing may not be the only pivot that could catalyse effective provision of water. This result shows that water asset financing as a single independent variable does not have a statistically significant impact on water provision in South Africa. This shows that although water infrastructure financing serves as a catalyst for water provision, its local authorities do not allocate finances appropriatesly due to other factors such as poor governance and lack of accountability, then water cannot be adequately provided to members of communities, which violates the principles of Stewardship and Agency Theories. This statistical finding concurs with the observation by various scholars (Badu et al., 2012; Allen & Pyke, 2013; Chan & Ameyaw; 2013) that water asset financing may not have

a direct statistical contribution to water provision suggesting that there may be other factors such as financial models and policy reform, regulation, governance and accountability that could negatively affect sustainable water provision (Badu et al., 2012; Allen & Pyke, 2013; Chan & Ameyaw; 2013). On the other hand, other researchers are of the opinion that infrastructure financing is fundamental for sustainable water provision (Briscoe, 1999; Akhmouch, 2012; Ruiters, 2013).

Thus based on this outcome, it is important to note that the statistically insignificant impact of water provision could be as a result of inadequate financial models, policy framework, ineffective regulation, poor governance and lack of accountability for effective water provision in South Africa (Ruiters, 2013; Allen & Pyke; 2013; Chan & Ameyaw; 2013). Furthermore, lack of investment capacity; implementation and revenue mobilisation, could be responsible for failure of implementing innovative financing of infrastructure in developing countries including South Africa.

Based on the preceding explanation, the first research objective was achieved.

10.2.2 Objective 2: To examine whether there is a relationship between financial governance and water provision

The second objective of this research was to examine whether there is a relationship between financial governance and water provision. In order to achieve this objective, the researcher reviewed relevant literature discussing the relationship between financial governance and water provision. The reviewed literature presented several varied findings which were positive (Jiménez & Pérez-Foguet, 2010; Pahl-Wostl et al., 2013a), as well as negative or no relationship (Rugemalila & Gibbs, 2015; Dellapenna et al., 2013; Peloso, 2014). As a result, it became appropriate to examine this relationship within the context of South Africa.

The researcher progressed to collect financial governance and water provision data from the archives of the World Bank which is the repository of governance for the Republic of South Africa among other countries in the world. These variables were then analysed to establish a relationship using the regression statistics, where the alpha (α) level of acceptance was set at 0.05 (5%).

From the statistical analyses results, although, a relationship does exist between governance effectiveness and water provision, however, governance effectiveness proved to be statistically insignificant at a *P* value = 0.09527 (0.1%) which is more than the stated research alpha (α) level of 0.05. This means that the relationship between governance effectiveness and water provision is weak, indicating that governance effectiveness may not be the only pivot that could catalyse effective provision of water. This result shows that financial governance, as a single independent variable, does not have a statistically significant impact on water provision in South Africa. This finding indicates that although effective governance forms the basis of Stewardship and Agency theories, there may be other factors that could hinder effective governance, thereby compromising effective water provision to communities.

This statistical finding harmonises with the opinion of various scholars (Jiménez & Pérez-Foguet, 2010; Pahl-Wostl et al., 2013a) that financial governance may not have a direct statistical contribution to water provision implying that there may be other factors such as policy reform, infrastructure financing and accountability that could negatively affect sustainable water provision. Other researchers are of the opinion that infrastructure financing is fundamental for sustainable water provision (Rugemalila & Gibbs, 2015; Dellapenna et al., 2013; Peloso, 2014).

Consequently, based on this outcome, it is worth noting that the statistically insignificant impact of financial governance could result from inadequate infrastructure financing, policy framework, regulation, poor governance and lack of accountability for effective water provision in South Africa (Ruiters, 2013; Allen & Pyke, 2013; Chan & Ameyaw, 2013). Furthermore, lack of infrastructure financing, revenue mobilisation, policy reform, and accountability could be responsible for failure implementing innovative financing of infrastructure in developing countries including South Africa. Built on the above explanation, the second research objective was achieved.

10.2.3 Objective 3: To assess the relationship between financial accountability and water provision

The third objective of this research was to assess the relationship between financial accountability and water provision. In order to achieve this objective, a relevant literature review discussing the relationship between financial accountability and water

provision was conducted by the researcher. The reviewed literature revealed several diverse findings which were positive (Bain et al., 2012; Georgiadou et al., 2014; Wild, 2015; Setlhogile et al., 2016; Fonjong & Fokum, 2017), as well as negative and/or no relationship (Kumar et al., 2017; Davis, 2014; Cosgrove & Rijsberman, 2014; Moriarty et al., 2013). It then became necessary to examine this relationship within the context of South Africa.

The researcher proceeded to collect accountability and water provision data from the archives of the World Bank which is the repository of accountability for South Africa among other countries in the world. These variables were then analysed to establish a relationship using the regression statistics, where the alpha (α) level of acceptance was set at 0.05 (5%).

Following the statistical analysis, the results proved to be statistically significant at a *P*-value = 0.00342 which is less than the stated research alpha (α) level of 0.05. This means that the relationship between accountability and water provision is strong, indicating that accountability could serve as a promoter for the effective provision of water. In therms of the Agency theory, local authorizes are expected to be accountable to members of the community since the community members are tax payers. As stewards local authorities are entrusted with the responsibility for effectice communication to members of the community regarding the status of water demand and availability.

This statistical finding concurs with the views of various researchers (Bain et al., 2012; Georgiadou et al., 2014; Wild, 2015; Setlhogile et al., 2016; Fonjong & Fokum, 2017) that financial accountability may have a direct statistical impact on water provision. On the other hand, other researches are of the opinion that financial accountability is not a promoter for sustainable water provision (Kumar et al., 2017; Davis, 2014; Cosgrove & Rijsberman, 2014; Moriarty et al., 2013).

Consequently, based on this outcome, it is worth noting that the statistically significant impact of financial accountability could result in the promotion of water provision. However, poor governance, legislation and regulatory decrees, poor water distribution, insufficient infrastructure financing, poor management of funds, lack of public engagement and policy framework, lack of infrastructure financing; revenue mobilisation, and policy reform are some of the factors that could be responsible for

failure of implementing effective water provision in South Africa (Kumar et al., 2017; Davis, 2014; Cosgrove & Rijsberman, 2014; Moriarty et al., 2013).

Based on the above explanation, the third research objective was achieved.

10.2.4 Objective 4: To examine how water provision relate with rural poverty alleviation.

The fourth objective of this research was to examine how water provision relate with rural poverty alleviation. In order to achieve this objective, the researcher first reviewed relevant literature focusing on the relationship between water provision and rural poverty alleviation. Various mixed findings were identified from the literature, some with positive findings (Mancosu et al., 2015; Daryanto et al., 2016; Meng et al., 2016), others with negative and/or no relationship (Hadebe et al., 2017; Food And Agriculture Organisation of the United Nations, 2016; De Fraiture et al., 2014; Dile et al., 2013; Qureshi et al., 2013). It then became pertinent to examine this relationship within the South African context.

The researcher proceeded to collect water provision data and incidence of poverty data; cereal production and water provision data were also collected from the archives of the Food and Agriculture Organisation of the United Nations (FAO) and TCTA which is the custodian of water infrastructure for the Republic of South Africa. These variables were then analysed to establish a relationship using the regression statistics, where the alpha (α) level of acceptance was put at 0.05 (5%).

From the statistical analysis results, a relationship does exist between water provision and incidence of poverty and between cereal production and water provision, where cereal production proved to be statistically significant at a *P*-value = 0.007075 which is less than the stated research alpha (α) level of 0.05. This means that the relationship between cereal production and water provision is strong. The result shows that water provision does have a statistically significant impact on water provision in South Africa, suggesting that water asset promotes water availability, which in turn, promotes cereal production, thus alleviating poverty particularly in the rural poor communities in South Africa. This observation is aligned with the Agency theory where water providers are entrusted with the responsibility of providing water through the relevant infrastructure.

Therefore the availability of a suitable water infrastructure by local authoriteas is aligned with Stewardship Theory since local authorities are viewed by publis as servants who ensures that water is made available to poor communities, enabling them to improve their livelihoods through subsistence farming and staple food production, thus alleviating poverty.

This statistical finding corroborates with the observation of various scholars (Mancosu et al., 2015; Daryanto et al., 2016; Meng et al., 2016) that water provision may have a direct statistical impact on cereal production. Contrary to this, other researches are of the opinion that water provision is not a catalyst for cereal production (Hadebe et al., 2017; Food and Agricultural Organisation, 2016; De Fraiture et al., 2014; Dile et al., 2013; Qureshi et al., 2013).

Thus, based on this outcome, it is important to note that the statistically significant impact of water provision could result in the promotion of cereal production in South Africa (Mancosu et al., 2015; Daryanto et al., 2016; Meng et al., 2016). Moreover, in the interest of rural poverty alleviation, a paradigm shift, adaptation to climate change and sustainable and innovative agricultural technology, are necessary to enhance sustainable production of cereal in spite of persistent drought conditions in arid and semi-arid developing countries including South Africa (Hadebe et al., 2017; Food and Agricultural Organisation, 2016; De Fraiture et al., 2014; Dile et al., 2013; Qureshi et al., 2013).

Based on the above explanation, the fourth research objective was achieved.

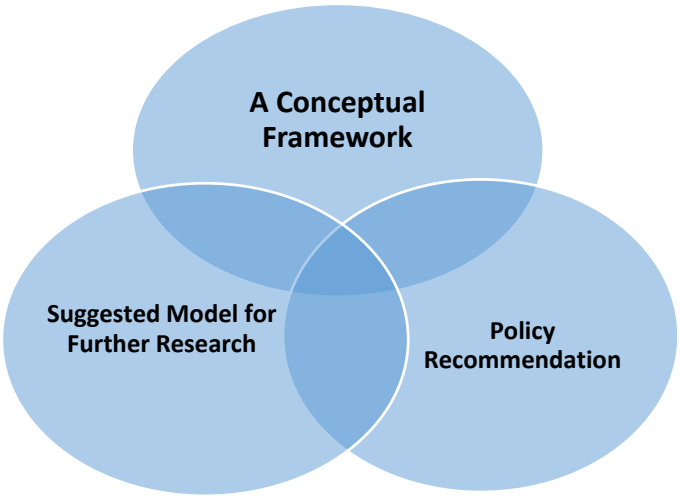
10.3 Objective 5: Contribution to knowledge

To propose a framework for understanding catalysts for water provision and corollaries

It is expected that research at the doctorate level should contribute new knowledge.

This research has contributed new knowledge in three different spheres as in Figure 10.1 below:

Figure 10.1 Tripod Original Contribution of Research



Source: Researcher's original contribution

These different contributions are presented in the following sections.

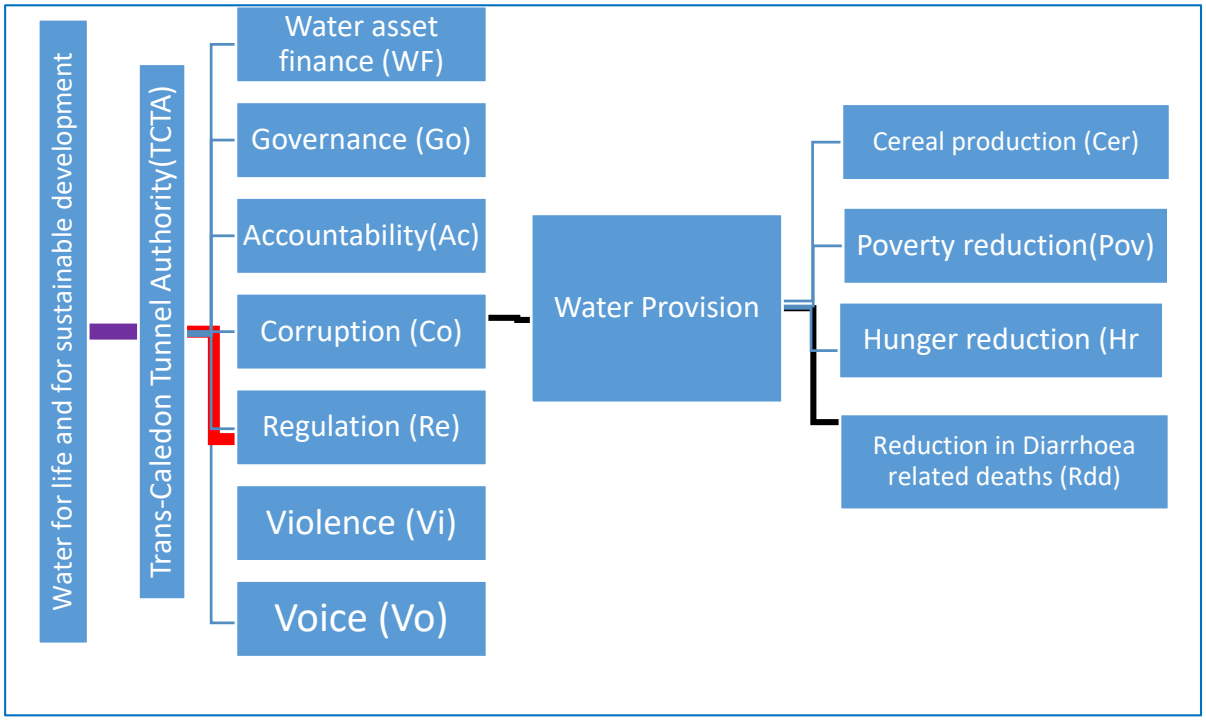
10.3.1 A framework for understanding the catalysts for water provision and corollaries

The first original contribution of this research is through the initiation of an original framework for understanding and researching the catalyst for water pr1.1ovision and the attendant corollaries of water provision. Such a framework is not known in the water management and development literature.

The framework (Figure 10.2) arises from the literature and empirical findings of this thesis. The research finds that water is essential for life and therefore constitutes a basic right of citizens of South Africa and of other nations of the world. Given the water relatedness to life, it is captured as an essential aspect of the United Nations Sustainable Development Goals. Given this importance, the Republic entrusts water asset financing and provisioning with the Trans-Caledon Tunnel Authority (TCTA), which is responsible for the development of bulk water infrastructure such as dams and piple line for water storage and tranfer from the source to the users in South Africa. Little exists in the literature on how this authority's function has been impacting on water provision in the country, therefore, Figure 10.2 frames a linkage between water

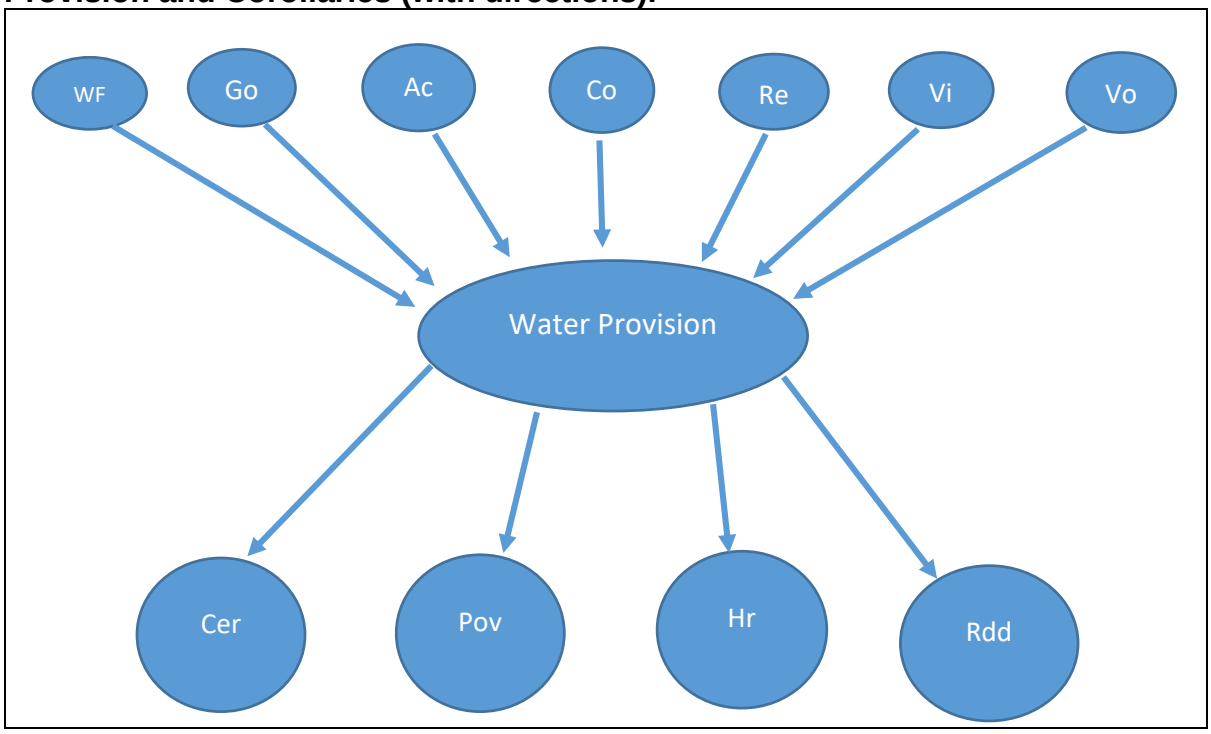
for life and sustainability agenda with the TCTA. A conceptual understanding of the effectiveness of TCTA should be studied and/or researched under the enabling governance factors such as water asset finance for water infrstructure development, governance effectiveness, accountability, corruption effect, regulation effect, involvement of community voice and the effect of social violence. These factors were revealed in this research as constituting positive or negative influences on water provision. The final tree on the framework, which is made up of four branches constituting the corollaries of water provision. These in turn deserve careful consideration by water and development practitioners to understand and research inter-linkages between water provision, cereal production, poverty alleviation, hunger reduction and reduction in diarrhoea related deaths in South Africa and other nations. The researcher hopes that this framework should not only constitute a research agenda, but should also assist in water researches and other related development pedagogy – in classrooms and other learning environments. The graphical representation of the thesis original contributory framework is presented in Figure 10.2a. The Figure 10.2a is further enhanced with directional arrows in Figure 10.2b. Drawing from the analysis in preceding sections, the framework does offer practical and policy implication in that, water asset finance alone cannot effectively lead to water provision given that the P value from the regression analysis was more than 0.05. A pragmatic water asset finance must have an enabling effective governance system, which would thus embed accountability on the financial provision for water assets. This thus would require that government should enhance policies on water asset finance allocation to provinces; such policies can thus be based on the prior governance and accountability performance rating of each provincial water management division.

Figure 10.2a Conceptual Framework for Understanding Catalysts for Water Provision and Corollaries.



Source: Researcher's original contribution

Figure 10.2b Conceptual Framework for Understanding Catalysts for Water Provision and Corollaries (with directions).



Source: Researcher's original contribution

10.3.2 Recommended Application of Framework to Future Research and Water Related Development Policy and Practice

In addition to the preceding thesis contribution to knowledge by providing a conceptual framework for understanding and researching catalysts for water provision and attendant corollaries, this thesis offers further contribution to future academic research and practical policy implication on water management. The following sections presents a recommended model for future research and a policy recommendation to improve water management.

10.3.2a Recommended Model for Further Research

OLS Model for further research on Water Asset Finance, Poverty, Hunger and Diarrhea Related Deaths

Model 1: Impact of water asset finance on Poverty

Future research should seek to discover a relationship between water provision and poverty by including six governance control variables in addition to the major independent variable (water finance). The suggested future research question should be whether water finance influences poverty alleviation. Therefore, the recommended model for such future research appears in model one below:

$$\gamma_1 = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 + \beta_5\chi_5 + \beta_6\chi_6 + \beta_7\chi_7 + \varepsilon \text{ ---------- } (1)$$

Where:

γ_1 **=** Poverty (dependent variable)

β_0 **=** regression intercept

$\beta_1 - \beta_6$ **=** regression coefficients

χ_1 **=** Water asset finance (WAFin) (independent variable 1)

Control variables

χ_2 **=** Governance effectiveness (control variable 1)

χ_3 **=** Accountability (ACC) (control variable 2)

χ_4 **=** Corruption (Corr) (control variable 3)

χ_5 **=** Regulation (Regu) (control variable 4)

χ_6**=** Violence (control variable 5)

χ_7 **=** Voice (control variable 6)

Model 2: Impact of water asset finance on Hunger

Furthermore, future research should attempt to ascertain a relationship between water provision and hunger by including six governance control variables in addition to the major independent variable (water finance).

In such future research, the suggested research question should be whether water finance influences hunger alleviation. Therefore, the recommended model for such future research appears in model two below:

$$\gamma_2 = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 + \beta_5\chi_5 + \beta_6\chi_6 + \beta_7\chi_7 + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where:

γ_2 **=** Hunger (dependent variable)

β_0 **=** regression intercept

β_1 **-** β_6 **=** regression coefficients

χ_1 **=** Water asset finance (WAFin) (independent variable 1)

Control variables

χ_2 **=** Governance effectiveness (control variable 1)

χ_3 **=** Accountability (ACC) (control variable 2)

χ_4 **=** Corruption (Corr) (control variable 3)

χ_5 **=** Regulation (Regu) (control variable 4)

χ_6**=** Violence (control variable 5)

χ_7 **=** Voice (control variable 6)

Model 3: Impact of water asset finance on Diarrhoea Related Deaths

In addition to preceding models, future research should also try to determine a relationship between water provision and diarrhoea related deaths by including six governance control variables in addition to the major independent variable (water finance).

In such future research, the suggested research question should be whether water finance influences diarrhoea related deaths. Therefore, the recommended model for such future research appears in model two below:

$\gamma_3 = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 + \beta_5\chi_5 + \beta_6\chi_6 + \beta_7\chi_7 + \varepsilon$ ……*(3)*

Where:

γ_3 **=** Diarrhoea Related Deaths (dependent variable)

β_0 **=** regression intercept

β_1 **-** β_6 **=** regression coefficients

χ_1 **=** Water asset finance (WAFin) (independent variable 1)

Control variables

χ_2 **=** Governance effectiveness (control variable 1)

χ_3 **=** Accountability (ACC) (control variable 2)

χ_4 **=** Corruption (Corr) (control variable 3)

χ_5 **=** Regulation (Regu) (control variable 4)

χ_6 **=** Violence (control variable 5)

χ_7 **=** Voice (control variable 6)

10.3.2b Recommendations for policy and practice

Drawing from the findings of this research, which includes findings from the literature and those from empirical data analyses, this research makede a third contribution through the following policy suggestions:

Rural Water Supply Policy: this research has uncovered evidence from the literature and from the results of data analyses that water provision is significantly related with poverty alleviation, mostly as water provision enhances cereal production, which is the staple food of the majority of South Africans. There is therefore need to introduce a rural water policy that would not depend on existing piped water, but such policy should make it mandatory for every rural settlement to have accessible boreholes and rainwater harvesting tanks and facilities. This policy would not only ensure readily available water for consumption, it will also ensure that rural dwellers can have small farms to grow vegetables and cereal to enhance subsistence farming, which will contribute to poverty alleviation.

Water Management: empirical findings and supportive literature from this research revealed that although a relationship does exist between water asset finance and water provision, however, an important point for policy makers to note is that effective

water provision does not significantly depend on the amount of finance provided only. The results show that provision of finance would foster effective water provision in an environment where corruption is non-existent, where accountability thrives and where peoples' voice are involved in water management. This research recommends that water management and oversight should be improved to reduce corruption by involving a significant representation of local communities in the water boards to relay the community's needs and concerns about water. Involvement of community members in water management would also assist to bolster accountability on the part of water finance managers when they are aware that the community is monitoring their operations. The research also recommends that water related corruption deserves reviewing and reclassifying to draw it closer to intentional threat to life. This is because water is life and therefore begets the principle of basic right to water. This should imply that corruption activities that obstruct water delivery, which supports life, should be treated by policy and enforcement agents as intention to cause a threat to life. Deaths related to water borne diarrhoea as reported in this research is a pointer to the pertinent need for this policy. It is likely that if this policy is instilled to the awareness of water management officials and those entrusted with water finance, water related corruption and non-water financial accountability would be reduced.

Training: since this research highlighted the interconnectivity between water and life, it therefore means that water management is not just like the management of any other social service; it can be related to the management of health and life. This research recommends that water managers – financial and non-financial managers – should receive mandatory regular training on the health-related implication of water provision. This would likely change the mind-set of water managers to appreciate the essential nature of water management.

10.3 Limitations of the research

Similar to any other research which is prone to some limitations, this research had some limitations which include amongst others, limited time coverage of data used in the research; data analysis technique which used only the OLS regression; limitation of independent variables to governance factors; and concentration of data collection on secondary data.

This research data covered only twenty-one years 1994 to 2014; although this research made the first attempt to peer into this angle of research in South Africa, but future researchers should extend the length of time to thirty or more years and possibly compare pre-independence data with post-independence data to see how the results may compare.

Data analysis was limited to the use of OLS in this research, although, the researcher applied some validity tests.It is recommended that future researchers apply a triangulation of analytical methods to see how the results may compare amongst the different analysis methods with a view to offering alternative policy suggestions.

In this research, the independent variables used constitute only the governance variables, namely accountability, governance effectiveness, corruption, and the peoples' voice. The thesis recommends that future researchers should consider including other non-governance independent variables such as population growth (a development variable) to see how such variable might impact water provision, to assist future policies on water supply.

Furthermore, this research used only secondary data; future researchers should consider blending the secondary data with some interviews to get first-hand information from water officials and the citizens that might assist with resolving implicit problems in water finance management and related water provision.

10.4 Conclusion

This research aimed to discover the relationship between water asset financing and water provision in South Africa. The research became important, as previous researchers seem to have neglected this important aspect of water management and related social development corollaries such as poverty alleviation and cereal production. The Agency and Stewardship Theories formed the basis of this research where in the context of the South African public water sector, the Department of Water and Sanitation serves as a steward to members of the public who are regarded as principals since they are taxpayers. Therefore, local water authorities serve as agents who are expected to provide optimum, efficient and sustainable water provision to members of the community of South Africa who are their principals which is in line with the Agency Theoretical framework.

The thesis was founded on five objectives amongst which the first four were tested statistically; the fourth objective provided an original contribution to knowledge.

The five objectives of the thesis were:

- To evaluate the relationship between water infrastructure financing and water provision.
- To examine whether there is a relationship between financial governance and water provision.
- To assess the relationship between financial accountability and water provision.
- To examine how water provision relates with rural poverty alleviation.
- To propose a framework for enhancing water infrastructure financing and water provision.

In order to achieve these objectives, the thesis employed a quantitative empirical design using archival data from the TCTA and the World Bank Governance Indicators. Data were collected for a period of 21 years, from the inception of democracy in 1994 to 2014. Data for research questions 1 – 3 were organised in time series fashion, but data for research question 4 test 4a were organised in panel data fashion. The analysis of data was by means of OLS regression statistics, which was validated by validity tests. Findings from the statistical analysis showed that although a relationship exists between water asset financing and water provision, the water asset finance, as a separate independent variable is not significantly related with water provision – showing that finance alone may not create the miracle of providing the needed water if not supported by other enabling variables. Similarly, the findings showed that although governance is related to water provision, no significant relationship exists between governance and water provision. Contrary to this, findings from the research showed that accountability is significantly related with water provision. This shows that in the absence of accountability, water finance and governance may not alone provide the desired water provision. Accountability is therefore portrayed as an important element in water management. Similarly, results from the research analysis found that water provision is significantly related with poverty alleviation. This finding elevates the

dire need for water, which supports production of staple food (cereal) in South Africa. Further findings from the research reveal that corruption, peoples' voice in water management, and social violence play an important role in supporting or marring water provision despite water finance.

Based on the thesis findings, the paper demonstrated an original contribution to knowledge in three ways; firstly by providing a framework for understanding and researching water asset finance, water provision and associated corollaries arising from water provision such as poverty, hunger, deaths related to water borne diarrhoea and cereal production. Secondly, the paper made a further contribution by providing three new research models for future research. The third orginal contribution of this thesis was through the provision of some policy recommendations to improve water management in the Republic of South Africa.

REFERENCES

Abdu-Raheem, K.A. & Worth, S.H. (2011). Household food security in South Africa: evaluating extension's paradigms relative to the current food security and development goals. *South African Journal of Agricultural Extension*, 39(2):91-103.

Abraham, B. and Ledolter, J. (2006). Burton. *Introduction to regression modeling*. Thomson Brooks/Cole. Florence, Kentucky, U.S.A.: Duxbury.

Adamolekun, L. (2010). The Governors and the governed: Towards improved accountability for achieving good development performance. *Africa Review,* 2(2):105-138.

Afful-Koomson, T. (2015). The Green Climate Fund in Africa: what should be different? *Climate and Development,* 7(4):367-379.

African Development Bank (2016). Rural Water Supply and Sanitation Initiative. Available from: https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/rural-water-supply-sanitation-initiative/. (Accessed: 12 May 2017).

Akhmouch, A. (2012). Water Governance in Latin America and the Caribbean: A Multi-Level Approach. OECD Regional Development Working Papers, No. 2012/04, OECD Publishing, Paris. Available from: <http://dx.doi.org/10.1787/5k9crzqk3ttj-en> (Accessed: 25 November 2015).

Akinloye Akinboade, O., Chanceline Kinfack, E. & Putuma Mokwena, M. (2012). An analysis of citizen satisfaction with public service delivery in the Sedibeng district municipality of South Africa. *International Journal of Social Economics*, 39(3):182-199.

Alderman, H. & Del Ninno, C. (1999). Poverty issues for zero rating VAT in South Africa. *Journal of African Economies*, 8(2):82-208.

Alix-Garcia, J., Bartlett, A. & Saah, D. (2012). Displaced populations, humanitarian assistance and hosts: A framework for analyzing impacts on semi-urban households. *World Development*, 40(2):373-386.

Allen, J. & Pryke, M. (2013). Financialising household water: Thames Water, MEIF, and 'ring-fenced'politics. *Cambridge Journal of Regions, Economy and Society*, 6(3):419-439.

Bakker, K. (2013). Constructing 'public'water: The World Bank, urban water supply, and the biopolitics of development. *Environment and Planning D: Society and Space*, 31(2):280-300.

Bakre, O.M. & Lauwo, S. (2016). Privatisation and accountability in a "crony capitalist" Nigerian state. *Critical Perspectives on Accounting*, 39:45-58.

Banerjee, S.G., Foster, V., Ying, Y., Skilling, H. & Wodon, Q.T. (2010). Cost recovery, equity, and efficiency in water tariffs: Evidence from African utilities. *World Bank Policy Research Working Paper Series, Vol*. 5384. Available at SSRN: https://ssrn.com/abstract=1650475. (Accessed: 22 April 2017).

Baron, J.S., Hall, E.K., Nolan, B.T., Finlay, J.C., Bernhardt, E.S., Harrison, J.A., Chan, F. & Boyer, E.W. (2013). The interactive effects of excess reactive nitrogen and climate change on aquatic ecosystems and water resources of the United States. *Biogeochemistry,* 114(1-3):71-92.

Barron, O.V., Barr, A.D. & Donn, M.J. (2013). Effect of urbanisation on the water balance of a catchment with shallow groundwater. *Journal of Hydrology,* 485:162-176.

Bartram, J., Brocklehurst, C., Fisher, M.B., Luyendijk, R., Hossain, R., Wardlaw, & T. Gordon, B. (2014). Global monitoring of water supply and sanitation: history, methods and future challenges. *International journal of environmental research and public health*, 11(8):8137-8165.

Bashier, C. & Conway, D., 2016. Water resources transfers through southern African food trade: water efficiency and climate signals. *Environmental Research Letters*, 11(1):015005.

Bashier, E.E., Bashir, N.H., Mohamadani, A., Elamin, S.O. & Abdelrahman, S.H., (2015). A challenge of sustaining water supply and sanitation under growing population: A case of the Gezira State, Sudan. *International Journal of Water Resources and Environmental Engineering*, *7*(9):132-138.

Bastiaanssen, W.G., Verstegen, J.A., Steduto, P., Goudriaan, R. & Wada, Y. (2014), December. on the Global Water Productivity Distribution for Major Cereal Crops: some First Results from Satellite Measurements. (Abstract). In *AGU Fall Meeting,* 1:0522). Available from: http://adsabs.harvard.edu/abs/2014AGUFMGC21B0522B. (Accessed: 12 November 2016).

Bauer, M.W. & Gaskell, G. Berg (Eds.) (2000). *Qualitative researching with text, image and sound: A practical handbook for social research*. London. Sage.

Becker, J.M., Ringle, C.M., Sarstedt, M. & Völckner, F. (2015). How collinearity affects mixture regression results. *Marketing Letters*, 26(4), 643-659.

Beddington, J., Asaduzzaman, M., Fernandez, A., Clark, M., Guillou, M., Jahn, M., Erda, L., Mamo, T., Bo, N.V., Nobre, C.A. & Scholes, R. (2012). Achieving food security in the face of climate change: Final report from the Commission on Sustainable Agriculture and Climate Change. Available from: https://cgspace.cgiar.org/bitstream/handle/10568/35589/climate_food_commission-final-mar2012.pdf?sequence=1&isAllowed=y. (Accessed: 12 March 2017).

Bell, S.R., Cingranelli, D., Murdie, A. & Caglayan, A. (2013). Coercion, capacity, and coordination: Predictors of political violence. *Conflict Management and Peace Science*, 30(3):240-262.

Bendat, J.S. & Piersol, A.G. (2011). *Random data: analysis and measurement procedures* (Vol.729). New Jersey. John Wiley & Sons.

Benjamin, J.R. and Cornell, C.A., (2014). *Probability, statistics, and decision for civil engineers*. New York. Dover Publications, Inc.

Benson, D., Gain, A. & Rouillard, J. (2015). Water governance in a comparative perspective: From IWRM to a 'nexus' approach? *Water Alternatives,* 8(1).

Berg, A., Portillo, R., Yang, S.C.S. & Zanna, L.F. (2013). Public investment in resource-abundant developing countries. *IMF Economic Review*, 61(1):92-129.

Berg, B.L., Lune, H. & Lune, H. (2004). *Qualitative research methods for the social sciences* (Vol. 5). Boston, MA: Pearson.

Berg, S.V. (2013). Best practices in regulating State-owned and municipal water utilities. Available from: http://repositorio.cepal.org/handle/11362/4079. (Accessed: 13 November 2016).

Bhagwan J. (2014). *Water scarcity – an unresolved issue in many parts of the country leads to protests over service delivery*. Seminar social protests, scarcity and vulnerability of water services delivery. The WRC and UWC (PLAAS). A seminar on 13th September 2013. Stone Cradle Conference Centre, Pretoria, South Africa.

Bhattacharya, A., Romani, M. & Stern, N. (2012). Infrastructure for development: meeting the challenge. In *Centre for Climate Change Economics and Policy, Londres. Available from: www. cccep. ac. uk/Publications/Policy/docs/PP-infrastructure-for-development-meeting-the-challenge. pdf. Consultado el*. (Vol. 15) (Accessed: 15 February 2017).

Biesenthal, C. & Wilden, R. (2014). Multi-level project governance: Trends and opportunities. *International Journal of Project Management*, 32(8):1291-1308.

Biggs, E.M., Boruff, B., Bruce, E., Duncan, J., Haworth, B., Duce, S., Horsley, J., Curnow, J., Neef, A., McNeill, K. & Pauli, N. (2014). Environmental livelihood security in Southeast Asia and Oceania: a water-energy-food-livelihoods nexus approach for spatially assessing change. *IWMI White Paper*. Available from: https://eprints.soton.ac.uk/375451/. Accessed: 14 September 2016).

Biswas, P.K. (2012). Corporate Governance Guidelines in Bangladesh: Some Observations. *The Cost and Management,* (4). Available at SSRN: https://ssrn.com/abstract=2271156 (Accessed: 17 April 2016).

Blaikie, P., Cannon, T., Davis, I. & Wisner, B. (2014). *At risk: natural hazards, people's vulnerability and disasters.* London and New York: Routledge.

Blanc, E. & Strobl, E. (2014). Is small better? A comparison of the effect of large and small dams on cropland productivity in South Africa. *The World Bank Economic Review*, 28(3):545-576.

Boers, T.M. & Ben-Asher, J. (1982). A review of rainwater harvesting. *Agricultural water management*, *5*(2):145-158.

Bogardi, J.J., Dudgeon, D., Lawford, R., Flinkerbusch, E., Meyn, A., Pahl-Wostl, C., Vielhauer, K. & Vörösmarty, C. (2012). Water security for a planet under pressure: interconnected challenges of a changing world call for sustainable solutions. *Current Opinion in Environmental Sustainability*, 4(1):35-43.

Bourblanc, M. & Blanchon, D. (2014). The challenges of rescaling South African water resources management: Catchment Management Agencies and interbasin transfers. *Journal of Hydrology*, 519:2381-2391.

Box, R.C. (1999). Running government like a business implications for public administration theory and practice. *The American Review of Public Administration*, *29*(1):19-43.

Bradley, D.J. & Bartram, J.K. (2013). Domestic water and sanitation as water security: monitoring, concepts and strategy. *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, 371(2002): 20120420.

Bradshaw, D., Bourne, D. and Nannan, N. (2003). What are the leading causes of death among South African children. *MRC Policy Brief and Unicef*, *3*:1Á4.

Bradshaw, G. & Nomarwayi, T. (2016). Violent service delivery protests-the challenge of maintaining law and order: a case of the Nelson Mandela Bay Municipality. *Journal of Public Administration*, 51(3):408-422.

Brandt, A. (2014). Water Infrastructure Finance in California: Who Should Pay to Keep the Tap Running. *McGeorge L. Rev.*, 46: 165.

Bremer, J. & Bhuiyan, S.H. (2014). Community-led infrastructure development in informal areas in urban Egypt: A case study. *Habitat International*, 44:258-267.

Brineco-Garmendia, C., Smits, K. & Foster, V. (2008). “Financing infrastructure in Sub-Sahara Africa: Patterns, issues, and options.” In: AICD Background Paper 15, Africa Infrastructure Sector Diagnostic. Washington, DC: World Bank. Available from: http://www.eu-africa-infrastructure-tf.net/attachments/library/aicd-background-paper-15-fiscal-costs-summary-en.pdf. (Accessed: 12 March 2016).

Brinkerhoff, D.W., Wetterberg, A. & Dunn, S. (2012). Service delivery and legitimacy in fragile and conflict-affected states: Evidence from water services in Iraq. *Public Management Review*, 14(2):273-293.

Briscoe, J. (1999). The changing face of water infrastructure financing in developing countries. *International Journal of Water Resources Development*, 15(3):301-308.

Brown, J., Cairncross, S. & Ensink, J.H. (2013). Water, sanitation, hygiene and enteric infections in children. *Archives of disease in childhood*, 98(8):629-634.

Bryman, A. (2015). *Social research methods*. New York: Oxford university press.

Buhaug, H. & Urdal, H. (2013). An urbanization bomb? Population growth and social disorder in cities. *Global Environmental Change,* 23(1):1-10.

Burton, P., Gurrin, L. & Sly, P. (1998). Tutorial in biostatistics. Extending the simple linear regression model to account for correlated responses: an introduction to generalized estimating equations and multi-level mixed modeling. *Statistics in medicine*, *17*:1261-1291.

Business Dictionary (2016). Equity Investment. Available from: http://www.businessdictionary.com/definition/equity-investment.html. (Accessed: 29 February 2016).

Business Dictionary (2017a). Accountability. Available from: http://www.businessdictionary.com/definition/accountability.html. (Accessed 20 April 2017).

Business Dictionary (2017b). Sustainable Development. http://www.businessdictionary.com/definition/sustainable-development.html. (Accessed: 20 April 2017).

Carmona, G., Varela-Ortega, C. & Bromley, J. (2013). Participatory modelling to support decision making in water management under uncertainty: two comparative case studies in the Guadiana river basin, Spain. *Journal of environmental management*, 128:400-412.

Caron, M.I., Ficici, A. & Richter, C.L. (2012). The influence of corruption on corporate governance standards: shared characteristics of rapidly developing economies. *EMAJ: Emerging Markets Journal*, 2(1):21-37.

Carr, J.A., D'Odorico, P., Laio, F. & Ridolfi, L. (2013). Recent history and geography of virtual water trade. *PloS one,* 8(2):5825.

Carranza, L., Daude, C. & Melguizo, Á. (2014). Public infrastructure investment and fiscal sustainability in Latin America: Incompatible goals? *Journal of Economic Studies,* 41(1):29-50.

Carrigan, C. & Coglianese, C. (2011). The politics of regulation: From new institutionalism to new governance. *Political Science*, 14(1):107.

Carter, R.C., Tyrrel, S.F. and Howsam, P. (1999). The impact and sustainability of community water supply and sanitation programmes in developing countries. *Water and Environment Journal*, 13(4): 292-296.

Cave, K., Plummer, R. & De Loë, R. (2013). Exploring water governance and management in Oneida Nation of the Thames (Ontario, Canada): An application of the institutional analysis and development framework. *Indigenous Policy Journal*, *23*(4):1-27.

Chaffin, B.C., Garmestani, A.S., Gosnell, H. & Craig, R.K. (2016). Institutional networks and adaptive water governance in the Klamath River Basin, USA. *Environmental Science & Policy,* 57:112-121.

Chalmers, K., Godfrey, J.M. & Lynch, B. (2012). Regulatory theory insights into the past, present and future of general purpose water accounting standard setting. *Accounting, Auditing & Accountability Journal,* 25(6):1001-1024.

Chan, A.P., Lam, P.T., Wen, Y., Ameyaw, E.E., Wang, S. & Ke, Y. (2014). Cross-sectional analysis of critical risk factors for PPP water projects in China. *Journal of Infrastructure Systems*, *21*(1):04014031.

Chartres, C.J. & Noble, A. (2015). Sustainable intensification: overcoming land and water constraints on food production. *Food Security*, *7*(2):235-245.

Cheng, J.J., Schuster-Wallace, C.J., Watt, S., Newbold, B.K. & Mente, A. (2012). An ecological quantification of the relationships between water, sanitation and infant, child, and maternal mortality. *Environmental Health*, 11(1):1.

Chetty, S. & Luiz, J.M. (2014). The experience of private investment in the South African water sector: The Mbombela Concession. *Development Southern Africa*, *31*(4):563-580.

Christiaensen, L., Demery, L. & Kuhl, J. (2011). The (evolving) role of agriculture in poverty reduction - An empirical perspective. *Journal of development economics*, 96(2):239-254.

Clarvis, M.H., Fatichi, S., Allan, A., Fuhrer, J., Stoffel, M., Romerio, F., Gaudard, L., Burlando, P., Beniston, M., Xoplaki, E. & Toreti, A. (2014). Governing and managing water resources under changing hydro-climatic contexts: The case of the upper Rhone basin. Environmental Science & Policy, 43, pp.56-67.

Clasen, T.F. (2012). Millennium Development Goals water target claim exaggerates achievement. *Tropical medicine & international health*, 17(10):1178-1180.

Cohen, B.R., (2012). Fixing America's crumbling underground water infrastructure. *Issue Anal*, 4. Available from: http://www.truthaboutpipes.com/wp-content/uploads/2014/07/FixingAmericasWaterInfrastructure.pdf. (Accessed 14 July 2016).

Collier, P. & Cust, J. (2015). Investing in Africa's infrastructure: Financing and policy options. *Annu. Rev. Resour. Econ.,* 7(1):473-493.

Conceição, P., Levine, S., Lipton, M. & Warren-Rodríguez, A. (2016). Toward a food secure future: Ensuring food security for sustainable human development in sub-Saharan Africa. *Food Policy*, 60:1-9.

Cosgrove, W.J. & Rijsberman, F.R. (2014). *World water vision: making water everybody's business*. Routledge.

Coucil, W.U. (2012). Buried No longer: Confronting America's Water Infrastructure Challenge AWWA. Available from: http://www.climateneeds.umd.edu/reports/American-Water-Works.pdf. (Accessed: 21 May 2016).

Dangour, A.D., Watson, L., Cumming, O., Boisson, S., Che, Y., Velleman, Y., Cavill, S., Allen, E. & Uauy, R. (2013). Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. *The Cochrane Library*. Available from: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD009382.pub2/full. (Accessed: 14 May 2016)

Daryanto, S., Wang, L. & Jacinthe, P.A. (2016). Global synthesis of drought effects on maize and wheat production. *PloS one*, 11(5):e0156362.

Davis S. (2014). Why water systems fail part 2: lack of accountability? Available from; https://improveinternational.wordpress.com/2014/07/18/why-water-systems-fail-part-2-lack-of-accountability. (Accessed: 26 April 2016).

De Asís, M.G., O'Leary, D., Ljung, P. & Butterworth, J. (2009). Integrity, and Accountability in Water Supply and Sanitation: Action, Learning, Experiences. Available from: www.oecd.org/env/outreach/44475062.pdf. (Accessed: 08 March 2015).

De Fraiture, C., Fayrap, A., Unver, O. & Ragab, R. (2014). Integrated water management approaches for sustainable food production. *Irrigation and Drainage*, 63(2):221-231.

De Janvry, A. & Sadoulet, E. (2010). Agricultural growth and poverty reduction: Additional evidence. *The World Bank Research Observer* 25(1):1-20.

De Janvry, A. & Sadoulet, E. (2011). Subsistence farming as a safety net for food-price shocks. *Development in Practice*, 21(4-5):472-480.

De Kwaadsteniet, M., Dobrowsky, P.H., Van Deventer, A., Khan, W. & Cloete, T.E., (2013). Domestic rainwater harvesting: microbial and chemical water quality and point-of-use treatment systems. *Water, Air, & Soil Pollution*, 224(7):1-19.

DeLeo, R.A. (2015). *Anticipatory Policymaking: When Government Acts to Prevent Problems and why it is So Difficult* (Vol. 14). New York. Routledge.

Della Croce, R. & Yermo, J. (2013). Institutional investors and infrastructure financing. *OECD Working Papers on Finance, Insurance and Private Pensions,* (36):1.

Dellapenna, J.W., Gupta, J., Li, W. & Schmidt, F. (2013). Thinking about the future of global water governance. *Confronting Ecological and Economic Collapse: Ecological Integrity for Law, Policy and Human Rights*, *120*.

Delmail, D., Labrousse, P. & Botineau, M., 2011. The most powerful multivariate normality test for plant genomics and dynamics data sets. *Ecological Informatics*, 6(2):125-126.

Department of Agriculture Forestry and Fisheries (1997). Food security policy for South Africa. Available at: http://www.nda.agric.za/docs/Foodsecurity/foodsecurity.htm. (Accessed: 24 April 2017).

Department of Agriculture Forestry and Fisheries (2012). Strategic plan 2012/2013 – 2016/2017. Available from: http://www.nda.agric.za/doaDev/topMenu/StratPlan201213-201617.pdf. (Accessed: 24 April 2017).

Department of Water Affairs (2012). Sanitation services – quality of sanitation in South Africa. Report on the Status of sanitation services in South Africa, Mar 2012; p 17. Available from: http://www.sahrc.org.za/home/21/files/Quality%20of%20sanitation%20Main%20report%20April%202012%20final%20Aug%202012.pdf> (Accessed: 1 November 2016).

Dercon, S. (2009). Rural poverty: Old challenges in new contexts. *The World Bank Research Observer*, p.lkp003. Available from: https://academic.oup.com/wbro/article-abstract/24/1/1/1672378/Rural-Poverty-Old-Challenges-in-New-Contexts. (Accessed: 1 November 2015).

Derne, B.T., Weinstein, P. and Lau, C.L. (2015). Wetlands as Sites of Exposure to Water-Borne Infectious Diseases. *Wetlands and Human Health,* 5:45-74. Available from Springer Netherlands database: https://link.springer.com/chapter/10.1007/978-94-017-9609-5_4. (Accessed: 22 March 2017).

Diamantopoulos, A. (2006). The error term in formative measurement models: interpretation and modeling implications. *Journal of Modelling in Management*, 1(1):7-17.

Dile, Y.T., Karlberg, L., Temesgen, M. & Rockström, J. (2013). The role of water harvesting to achieve sustainable agricultural intensification and resilience against water related shocks in sub-Saharan Africa. *Agriculture, ecosystems & environment*, 181:69-79.

Dixon, J., Scura, L., Carpenter, R. & Sherman, P. (2013). *Economic analysis of environmental impacts.*London. Earthscan.

Dobrowsky, P.H., De Kwaadsteniet, M., Cloete, T.E. & Khan, W. (2014). Distribution of indigenous bacterial pathogens and potential pathogens associated with roof-harvested rainwater. *Applied and environmental microbiology*, 80(7):2307-2316.

Döll, P., Hoffmann-Dobrev, H., Portmann, F.T., Siebert, S., Eicker, A., Rodell, M., Strassberg, G. & Scanlon, B.R. (2012). Impact of water withdrawals from groundwater and surface water on continental water storage variations. *Journal of Geodynamics*, 59:143-156.

Dong, C., Schoups, G. & Van de Giesen, N. (2013). Scenario development for water resource planning and management: a review. *Technological forecasting and Social change,* 80(4):749-761.

Dora, C., Haines, A., Balbus, J., Fletcher, E., Adair-Rohani, H., Alabaster, G., Hossain, R., De Onis, M., Branca, F. & Neira, M. (2015). Indicators linking health and sustainability in the post-2015 development agenda. *The Lancet*,*385* (9965):380-391.

Dube, E., Mare-Patose, R., Kilian, W., Barnard, A. & Tsilo, T.J. (2016a). Identifying high-yielding dryland wheat cultivars for the summer rainfall area of South Africa. *South African Journal of Plant and Soil*, 33(1):77-81.

Dube, T., Moyo, P., Ncube, M. & Nyathi, D. (2016b). The Impact of Climate Change on Agro-Ecological Based Livelihoods in Africa: A Review. *Dube T, Moyo P, Mpofu M, Nyathi D (2016), The impact of climate change on agro-ecological*

based livelihoods in Africa: A review, Journal of Sustainable Development, 9(1), 256-267.

Dupraz, C.L. & Postolle, A. (2013). Food sovereignty and agricultural trade policy commitments: How much leeway do West African nations have? *Food Policy*, 38:115-125.

Earle, A. (Editor). (2013). *Transboundary water management: principles and practice*. London, Washington DC: Earthscan.

Earle, A., Lungu, G., & Malzbender, D. (2008). Mapping of integrity and accountability in water activities and relevant capacities in the SADC-region. Stockholm International Water Institute (SIWI). Available from: http://dlc.dlib.indiana.edu/dlc/handle/10535/5155. Accessed: 12 Decenber 2016).

Eberhard, A. and Shkaratan, M. (2012). Powering Africa: Meeting the financing and reform challenges. *Energy Policy*, *42*, 9-18.

Edwards, B., Yilmaz, S. & Boex, J. (2014). Local Government Discretion and Accountability in Sierra Leone. Urban Institute Center on International Development and Governance Working Paper, (2014-01). Available from: http://www.urban.org/sites/default/files/publication/22546/413101-Local-Government-Discretion-and-Accountability-in-Sierra-Leone.PDF. (Accessed: 21 March 2015).

Effah Ameyaw, E. & Chan, A.P. (2013). Identifying public-private partnership (PPP) risks in managing water supply projects in Ghana. *Journal of Facilities Management*, 11(2):152-182.

Egan, M. (2014). Making water count: water accountability change within an Australian university. *Accounting, Auditing & Accountability Journal*, 27(2):259-282.

Egunjobi, T.A. (2013). An econometric analysis of the impact of Corruption on economic growth in Nigeria. *Journal of Business Management and Economics*, 4(3):054-065.

Eifert, B., Gelb, A. & Ramachandran, V. (2008). The cost of doing business in Africa: Evidence from enterprise survey data. *World Development*, *36*(9):1531-1546.

Ellis, J.B. (2013). Sustainable surface water management and green infrastructure in UK urban catchment planning. *Journal of Environmental Planning and Management*, *56*(1):24-41.

El-Sadek, A. (2010). Virtual water trade as a solution for water scarcity in Egypt. *Water Resources Management,* 24(11):2437-2448.

Emmett, T. (2000). Beyond community participation? Alternative routes to civil engagement and development in South Africa. *Development Southern Africa*, *17*(4):501-518.

Enninful, J.P. (2014). *Rainwater harvesting: a sustainable practice for low-income housing in South Africa.* Doctoral dissertation. Johannesburg: Wits University, 2014. Available from: http://wiredspace.wits.ac.za/handle/10539/13642. Accessed: 5 April 2016).

Ercumen, A., Gruber, J.S. and Colford Jr, J.M. (2014). Water distribution system deficiencies and gastrointestinal illness: a systematic review and meta-analysis. *Environmental Health Perspectives*, *122*(7), p.651.

Eslamian, D & Arif, K. (2011). Agriculture for Poverty Reduction in Rural District of Bakhtegan in Fars Province, Iran. *Journal of American Science,* 2011; 7(12):222-225.

Estache, A., Wodon, Q. & Lomas, K. (2014). *Infrastructure and Poverty in Sub-Saharan Africa*. New York: Palgrave Macmillan.

Everitt, B. (1998). *The Cambridge Dictionary of Statistics*. Cambridge, UK, New York: Cambridge University Press.

Explorable.com (2016). "Type I Error and Type II Error - Experimental Errors". Available from: https://explorable.com/type-i-error. (Accessed: 30 November 2016).

Famiglietti, J.S. (2014). The global groundwater crisis. *Nature Climate Change*, 4(11):945-948.

FAOSTAT (2012). Production Indices. Available from: http://www.fao.org/faostat/en/#data/QI. (Accessed: October 6, 2015).

Farreny, R., Morales-Pinzón, T., Guisasola, A., Taya, C., Rieradevall, J. & Gabarrell, X. (2011). Roof selection for rainwater harvesting: quantity and quality assessments in Spain. *Water Research*, 45(10):3245-3254.

Fellows, R.F. & Liu, A.M. (2015). *Research methods for construction*. United Kingdom: John Wiley & Sons.

Ferrar, K.J., Michanowicz, D.R., Christen, C.L., Mulcahy, N., Malone, S.L. & Sharma, R.K. (2013). Assessment of effluent contaminants from three facilities discharging Marcellus Shale wastewater to surface waters in Pennsylvania. *Environmental science & technology*, 47(7):3472-3481.

Fischer, K. & Hajdu, F. (2015). Does raising maize yields lead to poverty reduction? A case study of the Massive Food Production Programme in South Africa. *Land Use Policy*, 46:304-313.

Flore, L. (2004). World Bank (by)," World Development Report 2004: Making Services Work for Poor People, London, Oxford University Press. *Diritto pubblico*, 10(1):385-402.

Flörke, M., Kynast, E., Bärlund, I., Eisner, S., Wimmer, F. & Alcamo, J. (2013). Domestic and industrial water uses of the past 60 years as a mirror of socio-economic development: A global simulation study. *Global Environmental Change*, 23(1):144-156.

Fogde, M., Macario, L. & Carey, K. (2013). Water supply and sanitation. *The Role of Ecosystems in Disaster Risk Reduction*, p.270.

Fonjong, L. & Fokum, V. (2017). Water Crisis and Options for Effective Water Provision in Urban and Peri-Urban Areas in Cameroon. *Society & Natural Resources*, *30*(4):488-505.

Food and Agriculture Organisation of the United Nations (FAOUN). Nd. Crop Statistics. Available from: http://fenix.fao.org/faostat/beta/en/#data/QC (Accessed: 14 October 2016).

Foster, V. & Briceño-Garmendia, C. (2010). Africa's infrastructure. A Time for Transformation. A co-publication of the Agence Française de Développement

and the World Bank. *Available from: http://webcache. googleusercontent. com/search* (Accessed on 22 April 2017).

Frost, J. (2013). Regression analysis: How do I interpret R-squared and assess the goodness-of-fit. *The Minitab Blog*, 30.

Furlong, C., De Silva, S., Guthrie, L. & Considine, R. (2016). Developing a water infrastructure planning framework for the complex modern planning environment. *Utilities Policy,* 38:1-10.

Gandure, S., Walker, S. & Botha, J.J. (2013). Farmers' perceptions of adaptation to climate change and water stress in a South African rural community. *Environmental Development*, 5:39-53.

Garnett, T., Appleby, M.C., Balmford, A., Bateman, I.J., Benton, T.G., Bloomer, P., Burlingame, B., Dawkins, M., Dolan, L., Fraser, D. & Herrero, M. (2013). Sustainable intensification in agriculture: premises and policies. *Science*, 341(6141):33-34.

Gatti, S. (2013). *Project finance in theory and practice: designing, structuring, and financing private and public projects*. Waltman, US: Academic Press.

Gaventa, J. & McGee, R. (2013). The impact of transparency and accountability initiatives. *Development Policy Review*, *31*(s1).

Gay, L.F. & Sinha, S.K. (2014). Water Infrastructure Asset Management Primer. *Water Intelligence Online,* 13:9781780406145.

Gemmell, M.E. & Schmidt, S. (2010). Potential links between irrigation water quality and microbiological quality of food in subsistence farming in Kwazulu-Natal, South Africa. *Current research, technology and education topics in applied microbiology and microbial biotechnology*, 1190-1195.

Georgiadou, Y., Lungo, J.H. & Richter, C. (2014). Citizen sensors or extreme publics? Transparency and accountability interventions on the mobile geoweb. *International Journal of Digital Earth*, 7(7):516-533.

Gersonius, B., Ashley, R., Pathirana, A. & Zevenbergen, C. (2013). Climate change uncertainty: building flexibility into water and flood risk infrastructure. C*limatic change,* 116(2):411-423.

Ghasemi, A. & Zahediasl, S. (2012). Normality tests for statistical analysis: a guide for non-statisticians. *International journal of endocrinology and metabolism*, 10(2):486-489.

Ghile, Y.B., Taner, M.Ü., Brown, C., Grijsen, J.G. & Talbi, A. (2014). Bottom-up climate risk assessment of infrastructure investment in the Niger River Basin. *Climatic change*, 122(1-2):97-110.

Giacomoni, M.H., Kanta, L. & Zechman, E.M. (2013). Complex adaptive systems approach to simulate the sustainability of water resources and urbanization. *Journal of Water Resources Planning and Management,* 139(5):554-564.

Gilbert, R., Stevenson, D., Girardet, H. & Stren, R. (2013). *Making cities work: Role of local authorities in the urban environment*. London: Earthscan.

Gilding, E.K., Frère, C.H., Cruickshank, A., Rada, A.K., Prentis, P.J., Mudge, A.M., Mace, E.S., Jordan, D.R. & Godwin, I.D. (2013). Allelic variation at a single gene increases food value in a drought-tolerant staple cereal. *Nature communications,* 4:1483.

Gill, S.E., Handley, J.F., Ennos, A.R. & Pauleit, S. (2007). Adapting cities for climate change: the role of the green infrastructure. *Built Environment,* (1978):115-133.

Gilliland, D.I. & Kim, S.K. (2014). When do incentives work in channels of distribution? *Journal of the Academy of Marketing Science*, 42(4):361-379.

Gleick, P.H. & Ajami, N. (2014). *The world's water volume 8: The biennial report on freshwater resources* (Vol. 8). Washington: Island press.

Global Water Partnership (GWP) (2000). Integrated Water Resources Management. GWP Technical Committee Background Paper 4. Stockholm: GWP.

Gong, P., Liang, S., Carlton, E.J., Jiang, Q., Wu, J., Wang, L. & Remais, J.V. (2012). Urbanisation and health in China. *The Lancet,* 379(9818):843-852.

Grabowski, P. & Haggblade, S. (2016). The Economics of Conservation Agriculture in Africa: Implications of Climate Change. In *Climate Change and Multi-Dimensional Sustainability in African Agriculture,* pp. 659-677. Springer International Publishing.

Grafton, R.Q., Pittock, J., Davis, R., Williams, J., Fu, G., Warburton, M., Udall, B., McKenzie, R., Yu, X., Che, N. & Connell, D. (2013). Global insights into water resources, climate change and governance. *Nature Climate Change,* 3(4):315-321.

Grain SA. 2015. Production Conditions in the 2014/2015 Production Season. Production research and development/Produksienavorsing en –ontwikkeling. Available from: http://www.grainsa.co.za/production-research-and-development/produksienavorsing-en--ontwikkeling-2. (Accessed: 17 October 2016).

Granit, J., Lymer, B.L., Olsen, S., Lundqvist, J. & Lindström, A. (2014). *Water governance and management challenges in the continuum from land to the coastal sea—spatial planning as a management tool*. *Water Policy*, 00(2017):1-19

Grassini, P., Eskridge, K.M. & Cassman, K.G. (2013). Distinguishing between yield advances and yield plateaus in historical crop production trends. *Nature Communications*, *4*.

Green, R.H. (1979). *Sampling design and statistical methods for environmental biologists*. Canada: John Wiley & Sons.

Greiling, D. & Grüb, B. (2015). Towards Citizen Accountability of Local Public Enterprises. *Annals of Public and Cooperative Economics*, 86(4):641-655.

Greiling, D. & Halachmi, A. (2013). Accountability and organisational learning in the public sector. *Public Performance & Management Review*, 36(3):380-406.

Grey, D., Garrick, D., Blackmore, D., Kelman, J., Muller, M. & Sadoff, C. (2013). Water security in one blue planet: twenty-first century policy challenges for science. Philosophical Transactions of the Royal Society of London A: *Mathematical, Physical and Engineering Sciences,* 371(2002):20120406. Available from http://rsta.royalsocietypublishing.org/content/371/2002/20120406.short (Accessed: 27 April 2017).

Griffin, J. (2008). *On Human Rights*, Oxford. Oxford University Press.

Griggs, D., Stafford-Smith, M., Gaffney, O., Rockström, J., Öhman, M.C., Shyamsundar, P., Steffen, W., Glaser, G., Kanie, N. & Noble, I. (2013). Policy: Sustainable development goals for people and planet. *Nature,* 495(7441):305-307.

Grindle, A.K., Siddiqi, A. & Anadon, L.D. (2015). Food security amidst water scarcity: Insights on sustainable food production from Saudi Arabia. *Sustainable Production and Consumption*, 2:67-78.

Gunther, I. & Fink, G. (2010). Water, sanitation and children's health: evidence from 172 DHS surveys. Policy Research working paper; no. WPS 5275; Paper is funded by the Knowledge for Change Program (KCP). Washington, DC: World Bank. Available from: http://documents.worldbank.org/curated/en/630921468151763344/Water-sanitation-and-childrens-health-evidence-from-172-DHS-surveys (Accessed: 19 October 2016).

Gupta, J. & Pahl-Wostl, C. (2013). Global water governance in the context of global and multilevel governance: its need, form, and challenges. *Ecology and Society,* 18(4):53.

Haddeland, I., Heinke, J., Biemans, H., Eisner, S., Flörke, M., Hanasaki, N., Konzmann, M., Ludwig, F., Masaki, Y., Schewe, J. Stacke, T. (2014). Global water resources affected by human interventions and climate change. *Proceedings of the National Academy of Sciences,* 111(9):3251-3256.

Hadebe, S.T., Modi, A.T. & Mabhaudhi, T. (2017). Drought Tolerance and Water Use of Cereal Crops: A Focus on Sorghum as a Food Security Crop in Sub-Saharan Africa. *Journal of Agronomy and Crop Science*, 203, (3): 177-191.

Haggblade, S., Staatz, J., Boughton, D., Diallo, B., Meyer, F., Traub, L.N. & Tschirley, D. (2015). Regional dimensions of South Africa's CAADP process: Lessons from West Africa. *African Journal of Agricultural and Resource Economics,* 10(1):32-50.

Hák, T., Janoušková, S. and Moldan, B., 2016. Sustainable Development Goals: A need for relevant indicators. *Ecological Indicators,* 60:565-573.

Hall, J.W., Lempert, R.J., Keller, K., Hackbarth, A., Mijere, C. and McInerney, D.J. (2012). Robust Climate Policies Under Uncertainty: A Comparison of Robust Decision Making and Info-Gap Methods. *Risk Analysis,* 32(10):1657-1672.

Hallegatte, S. (2009). Strategies to adapt to an uncertain climate change. *Global Environmental Change,* 19(2):240-247.

Hallegatte, S., Shah, A., Brown, C., Lempert, R. & Gill, S. (2012). Investment decision making under deep uncertainty-application to climate change. *World Bank Policy Research Working Paper,* (6193).

Halunga, A.G., Orme, C.D. and Yamagata, T., 2017. A heteroskedasticity robust Breusch–Pagan test for Contemporaneous correlation in dynamic panel data models. *Journal of Econometrics,* 198(2):209-230.

Hanjra, M. A., Qureshi, M. E. (2010). Global water crisis and future food security in an era of climate change. *Food Policy,* 35(5):365-377.

Hazelton, J. (2013). Accounting as a human right: the case of water information. *Accounting, Auditing & Accountability Journal*, 26(2):267-311.

Hazelton, J. (2014). Corporate water accountability–the role of water labels given non-fungible extractions. *Pacific Accounting Review*, 26(1/2):8-27.

Hazelton, J. (2015). Developments in Corporate Water Accounting and Accountability. In *Sustainability After Rio* (27-55). *Emerald Group Publishing Limited,* 8:27-55

Head, C. (2006). The Financing of Water Infrastructure A Review of Case Studies. *The World Bank, Washington DC, USA*, p.50. Available from: http://documents.worldbank.org/curated/en/259611468175789554/pdf/590700WP0Water1Box0349464B01PUBLIC1.pdf. (Accessed: 27 May 2016).

Henisz, W.J., Dorobantu, S. & Nartey, L.J. (2014). Spinning gold: The financial returns to stakeholder engagement. *Strategic Management Journal*, 35(12):1727-1748.

Hering, J. G., Waite, T. D., Luthy, R. G., Drewes, J. E., & Sedlak, D. L. (2013). A changing framework for urban water systems. *Environmental science & technology,* 47(19):10721-10726.

Hiller, V. & Verdier, T. (2014). Corporate culture and identity investment in an industry equilibrium. *Journal of Economic Behavior & Organisation*, 103:93-112.

Hilson, G. (2012). Corporate Social Responsibility in the extractive industries: Experiences from developing countries. *Resources Policy*, 37(2):131-137.

Hoekstra, A.Y. (2010). The global dimension of water governance: Why the river basin approach is no longer sufficient and why cooperative action at global level is needed. *Water,* 3(1):21-46.

Hon. Zuma J. G. (2014). State of the Nation Address by His Excellency by the President of the Republic of South Africa on the occasion of the Joint Sitting of Parliament, Cape Town. Available from: http://www.thepresidency.gov.za/speeches/state-nation-address-his-excellency-jacob-g-zuma,-president-republic-south-africa-1 . (Accessed 0n 11 October 2016).

Horlemann, L. & Dombrowsky, I. (2012). Institutionalising IWRM in developing and transition countries: the case of Mongolia. *Environmental Earth Sciences*, 65(5):1547-1559. Available from: https://ssrn.com/abstract=1829921 or http://dx.doi.org/10.2139/ssrn.1829921. (Accessed: 16 July 2016).

Huang, J.P., Guan, X.D. & Ji, F. (2012). Enhanced cold-season warming in semi-arid regions. *Atmospheric Chemistry and Physics*, 12(12):5391-5398.

Hubbard, R. (2004). Blurring the Distinctions Between p's and a's in Psychological Research. *Theory Psychology,* 14(3): 295-327.

Hunter, P.R., MacDonald, A.M. & Carter, R.C. (2010). Water supply and health. *PLoS Med*, *7*(11): 000361.

Hussein, K. & Nelson, J. (2016). *Sustainable livelihoods and livelihood diversification*. IDS Working Paper 69. Available from: https://vtechworks.lib.vt.edu/bitstream/handle/10919/66529/1950_wp69.pdf?sequence=1&isAllowed=y. (Accessed: 22 February 2017).

Hutchings, P., Chan, M.Y., Cuadrado, L., Ezbakhe, F., Mesa, B., Tamekawa, C. & Franceys, R. (2015). A systematic review of success factors in the community

management of rural water supplies over the past 30 years. *Water Policy,* 17(5):963-983.

Immerzeel, W.W., Van Beek, L.P.H., Konz, M., Shrestha, A.B. & Bierkens, M.F.P. (2012). Hydrological response to climate change in a glacierized catchment in the Himalayas. *Climatic change*, 110(3-4):721-736.

Institute on Governance (2015). Definition of Governance. Available from: http://www.iog.ca/Definition of governance. (Accessed: 25 February 2015).

Intergovernmental Panel on Climate Change (2014). *Climate Change 2014–Impacts, Adaptation and Vulnerability: Regional Aspects*. New York: Cambridge University Press.

Jackson, S., Tan, P.L., Mooney, C., Hoverman, S. & White, I. (2012). Principles and guidelines for good practice in Indigenous engagement in water planning. *Journal of Hydrology*, 474:57-65.

Jaglin, S. (2002). The right to water versus cost recovery: participation, urban water supply and the poor in sub-Saharan Africa. *Environment and Urbanization*, *14*(1):231-245.

Jansen, A., Stoltz, E. & Yu, D. (2013). The targeting of zero-rated basic foodstuffs under value-added tax (VAT) in South Africa. *Studies in Economics and Econometrics*, *37*(3):87-104.

Jara-Rojas, R., Bravo-Ureta, B.E. & Díaz, J. (2012). Adoption of water conservation practices: A socioeconomic analysis of small-scale farmers in Central Chile. *Agricultural Systems*, 110:54-62.

Javeline, D. (2014). The most important topic political scientists are not studying: adapting to climate change. *Perspectives on Politics*, 12(2):420.

Jeandron, A., Saidi, J.M., Kapama, A., Burhole, M., Birembano, F., Vandevelde, T., Gasparrini, A., Armstrong, B., Cairncross, S. & Ensink, J.H. (2015). Water Supply Interruptions and Suspected Cholera Incidence: A Time-Series Regression in the Democratic Republic of the Congo. *PLoS Med*, 12(10):1001893.

Jeuland, M.A., Fuente, D.E., Ozdemir, S., Allaire, M.C. & Whittington, D. (2013). The long-term dynamics of mortality benefits from improved water and sanitation in less developed countries. *PloS one*, 8(10):74804.

Jiménez, A. & Pérez-Foguet, A. (2010). Challenges for water governance in rural water supply: lessons learned from Tanzania. *International Journal of Water Resources Development*, *26*(2):235-248.

Jobbins, G., Kalpakian, J., Chriyaa, A., Legrouri, A. & El Mzouri, E.H. (2015). To what end? Drip irrigation and the water–energy–food nexus in Morocco. *International Journal of Water Resources Development*, 31(3):393-406.

Jones, M.P. & Hunt, W.F. (2010). Performance of rainwater harvesting systems in the southeastern United States. *Resources, Conservation and Recycling*, 54(10):623-629.

Jones, P., Comfort, D. & Hillier, D. (2014). Water Stewardship and Corporate Sustainability. *Economia. Seria Management*, 17(2):358-372.

Jonga, W. (2012). Linking Public Finance to Local Government Finance: Some Critical Revelations. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2183878. (Accessed: 4 April 2015).

Jung, C., Voigt, S., Friedrich, O., Koch, M.C. & Frank, M. (2013). Campanian-Maastrichtian ocean circulation in the tropical Pacific. *Paleoceanography*, 28(3):562-573.

Kahinda, J.M.M., Taigbenu, A.E. & Boroto, J.R. (2007). Domestic rainwater harvesting to improve water supply in rural South Africa*. Physics and Chemistry of the Earth, Parts A/B/C,* 32(15):1050-1057.

K'Akumu, O.A. (2007). Toward effective governance of water services in Kenya. *Water Policy*, 9(5):529-543.

Kalbus, E., Kalbacher, T., Kolditz, O., Krüger, E., Seegert, J., Röstel, G., Teutsch, G., Borchardt, D. & Krebs, P. (2012). Integrated water resources management under different hydrological, climatic and socio-economic conditions. *Environmental Earth Sciences*, 65(5):1363-1366.

Kalu, O.H., Ibiam, J., Stephen, N.C. & Ijeoma, U.J. (2014). Rural Infrastructure Development: A Tool for Resolving Urbani zation Crisis. A Case Study of South-Eastern Nigeria. *World Environment,* 4(1):14-21.

Kang, D. & Lansey, K. (2012). Scenario-based robust optimization of regional water and wastewater infrastructure. *Journal of Water Resources Planning and Management,* 139(3):325-338.

Kang, K.H., Stein, L., Heo, C.Y. & Lee, S. (2012). Consumers' willingness to pay for green initiatives of the hotel industry. *International Journal of Hospitality Management,* 31(2):564-572.

Kanie, N. and Biermann, F., 2017. *Governing through goals: Sustainable development goals as governance innovation.* Cambridge, London. MIT Press.

Kaoneka, S.R., Saxena, R.K., Silim, S.N., Odeny, D.A., Rao, G., Rama, N.V.P., Shimelis, H.A., Siambi, M. & Varshney, R.K. (2016). Pigeonpea breeding in eastern and southern Africa: challenges and opportunities. *Plant Breeding,* 135 (2):148–154.

Karsten, A.S.J. (nd). Criminal liability negligence and environmental health. *Occupational Health Southern Africa*. Available from: http://occhealth.co.za/?/viewArticle/1634. (Accessed: 12 August 2016)

Kaufmann, D., Kraay, A. & Mastruzzi, M. (2009). Governance matters VIII: aggregate and individual governance indicators, 1996-2008. *World Bank policy research working paper,* (4978). Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1424591. (Accessed: 2 June 2016).

Kayode, A., Adagba, S.O. & Anyio, S.F. (2013). Corruption and Service Delivery: The Case of Nigerian Public Service. *Woodpecker Journal of Public Administration*, 1(1):001-006.

Kayser, G.L., Moriarty, P., Fonseca, C. & Bartram, J. (2013). Domestic water service delivery indicators and frameworks for monitoring, evaluation, policy and planning: a review. *International journal of environmental research and public health*, 10(10):4812-4835.

Kearney, M. & Van Heerden, J.H. (2015). Zero-rating food in South Africa: a computable general equilibrium analysis. *South African Journal of Economic and Management Sciences,* 7(3):521-531.

Kehler, J. (2013). Women and poverty: the South African experience. *Journal of International Women's Studies,* 3(1):41-53.

Khan, S., Shahnaz, M., Jehan, N., Rehman, S., Shah, M.T. & Din, I. (2013). Drinking water quality and human health risk in Charsadda district, Pakistan. *Journal of cleaner production*, 60:93-101.

Khan, S.J., Deere, D., Leusch, F.D., Humpage, A., Jenkins, M. & Cunliffe, D. (2015). Extreme weather events: Should drinking water quality management systems adapt to changing risk profiles? *Water research,* 85:124-136.

Kihara, J.M. (2016). *Managing water service providers in Kenya, a case for good corporate governance.* (Doctoral dissertation, Kenya: University of Nairobi).

Kirkpatrick, C., Parker, D. & Zhang, Y.F. (2006). Foreign direct investment in infrastructure in developing countries: does regulation make a difference? *Transnational corporations,* 15(1):143.

Kirsten, J.F. (2012). The political economy of food price policy in South Africa. *Food Price Policy in an Era of Market Instability*, 407.

Knox, J.W., Kay, M.G. & Weatherhead, E.K. (2012). Water regulation, crop production, and agricultural water management—understanding farmer perspectives on irrigation efficiency. *Agricultural Water Management*, 108:3-8.

Konar, M., Dalin, C., Suweis, S., Hanasaki, N., Rinaldo, A. & Rodriguez-Iturbe, I., (2011). Water for food: The global virtual water trade network. *Water Resources Research*, *47*(5). Available from: http://dx.doi.org/10.1029/2010WR010307. (Accessed: 24 November 2016).

Koolwal, G. & Van de Walle, D. (2013). Access to water, women's work, and child outcomes. *Economic Development and Cultural Change*, 61(2):369-405.

Kotloff, K.L., Nataro, J.P., Blackwelder, W.C., Nasrin, D., Farag, T.H., Panchalingam, S., Wu, Y., Sow, S.O., Sur, D., Breiman, R.F. & Faruque, A.S. (2013). Burden and aetiology of diarrhoeal disease in infants and young children in developing

countries (the Global Enteric Multicenter Study, GEMS): a prospective, case-control study. *The Lancet*, 382(9888):209-222.

Kramer, A. & Pahl-Wostl, C. (2014). The global policy network behind integrated water resources management: Is it an effective norm diffusor. *Ecology and Society*, 19(4):11.

Kula, N., Haines, A. & Fryatt, R. (2013). Reducing vulnerability to climate cange in sub-Saharan Africa: the need for better evidence. *PLoS Med*, 10(1), p.e1001374.

Kumar, T., Post, A.E. & Ray, I. (2017). Transparency 'Fixes' for Local Public Services: Field Experimental Evidence from Bangalore's Water Sector. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2902968. (Accessed 22 February 2017).

Kurniasih, H. (2008). Water Not For All: The Consequences of Water Privatisation in Jakarta, Indonesia. Available from: http://artsonline.monash.edu.au/mai/files/2012/07/henikurniasih.pdf. (Accessed 6 March 2015)

Kusharjanto, H. & Kim, D. (2011). Infrastructure and human development: the case of Java, Indonesia. *Journal of the Asia Pacific Economy*, 16(1):111-124.

Kwangware, J., Mayo, A. & Hoko, Z. (2014). Sustainability of donor-funded rural water supply and sanitation projects in Mbire district, Zimbabwe. *Physics and Chemistry of the Earth, Parts A/B/C,* 76:134-139.

Lal, R. (2013). Food security in a changing climate. *Ecohydrology & Hydrobiology*, 13(1):8-21.

Lalika, M.C., Meire, P. & Ngaga, Y.M. (2015). Exploring watershed conservation and water governance along Pangani River Basin, Tanzania. *Land Use Policy*, 48:351-361.

Langa, M. & Kiguwa, P. (2013). Violent masculinities and service delivery protests in post-apartheid South Africa: a case study of two communities in Mpumalanga. *Agenda*, 27(1):20-31.

Leduka, R., Crush, J., Frayne, B., McCordic, C., Matobo, T., Makoa, T.E.E., Mphale, M., Phaila, M. & Letsie, M. (2015). No. 21: The State of Poverty and Food Insecurity in Maseru, Lesotho. African Food Security Urban Network (AFSUN), Urban Food Security Series. Available from: http://www.afsun.org/wp-content/uploads/2016/06/AFSUN21.pdf. (Accessed: 22 December 2016).

Levy, P.S. & Lemeshow, S. (2013). *Sampling of populations: methods and applications*. New Jersey: John Wiley & Sons.

Lienert, J., Scholten, L., Egger, C. & Maurer, M. (2015). Structured decision-making for sustainable water infrastructure planning and four future scenarios. *EURO Journal on Decision Processes,* 3(1-2):107-140.

Liu, J., Folberth, C., Yang, H., Röckström, J., Abbaspour, K. & Zehnder, A.J. (2013). A global and spatially explicit assessment of climate change impacts on crop production and consumptive water use. *PLoS One*, 8(2):57750.

Liu, L., Oza, S., Hogan, D., Perin, J., Rudan, I., Lawn, J.E., Cousens, S., Mathers, C. & Black, R.E. (2015). Global, regional, and national causes of child mortality in 2000–13, with projections to inform post-2015 priorities: an updated systematic analysis. *The Lancet*, 385(9966):430-440.

Lobina, E. (2005). Problems with private water concessions: a review of experiences and analysis of dynamics. *International Journal of Water Resources Development*, 21(1):55-87.

Lockwood, H. & Smits, S. (2011). Supporting rural water supply: moving towards a service delivery approach. Practical Action Publishing. Available from: http://www.developmentbookshelf.com/doi/abs/10.3362/9781780440699. (Accessed: 17 July 2015).

Loo, S. L., Fane, A. G., Krantz, W. B., & Lim, T. T. (2012). Emergency water supply: A review of potential technologies and selection criteria. *Water research,* 46(10):3125-3151.

Lowndes, V. & Pratchett, L. (2012). Local governance under the coalition government: Austerity, localism and the 'Big Society'. *Local government studies*, *38*(1):21-40.

Luh, J., Baum, R. & Bartram, J. (2013). Equity in water and sanitation: Developing an index to measure progressive realization of the human right. *International Journal of Hygiene and Environmental Health*, *216*(6):662-671.

Luo, X.R. & Chung, C.N. (2013). Filling or abusing the institutional void? Ownership and management control of public family businesses in an emerging market. *Organisation Science*, *24*(2):591-613.

Luoma, S., Klein, J. & Backman, B. (2013). Climate change and groundwater: Impacts and Adaptation in shallow coastal aquifer in Hanko, south Finland. *Climate Change Adaptation in Practice: From strategy development to implementation,* 137-155.

Luoma, S., Klein, J. & Backman, B. (2013). Climate Change and Groundwater: Impacts and Adaptation in Shallow Coastal Aquifer in Hanko, South Finland, in Climate Change Adaptation in Practice: From strategy development to implementation. Oxford, UK: John Wiley & Sons, Ltd,. doi: 10.1002/9781118548165.ch11. Available from: http://onlinelibrary.wiley.com/doi/10.1002/9781118548165.ch11/summary. (Accessed: 25 May 2016).

Lynch, B.D. (2012). Vulnerabilities, competition and rights in a context of climate change toward equitable water governance in Peru's Rio Santa Valley. *Global Environmental Change*, *22*(2):364-373.

Mabhaudhi, T., Chibarabada, T. & Modi, A. (2016). Water-Food-Nutrition-Health Nexus: Linking Water to Improving Food, Nutrition and Health in sub-Saharan Africa. *International journal of environmental research and public health*, 13(1):107.

Macauley, H. & Ramadjita, T. (2015). Cereal Crops: Rice, Maize, Millet, Sorghum, Wheat. Paper presented at the conference of: Feed Africa, An Action plan for African Agricultural Transformation, held at Abdou Diouf International Conference Center, Darar, Senegal. Available from: http://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Cereal_Crops-_Rice__Maize__Millet__Sorghum__Wheat.pdf. (Accessed: 15 November 2016).

Machdar, E., Van Der Steen, N.P., Raschid-Sally, L. and Lens, P.N.L. (2013). Application of quantitative microbial risk assessment to analyze the public health risk from poor drinking water quality in a low-income area in Accra, Ghana. *Science of the Total Environment*, 449:134-142.

Mackintosh, G. & Colvin, C. (2003). Failure of rural schemes in South Africa to provide potable water. *Environmental Geology*, 44(1):101-105.

Maddala, G.S. & Lahiri, K. (1992). *Introduction to econometrics* (Vol. 2). New York: Macmillan.

Madi, T.C. (2016). *Service delivery and equitable distribution of water and sanitation services in the Newcastle Local Municipality*. Doctoral dissertation. Bloemfontein: University of the Free State).

Magliano, P.N., Murray, F., Baldi, G., Aurand, S., Páez, R.A., Harder, W. & Jobbágy, E.G. (2015). Rainwater harvesting in Dry Chaco: Regional distribution and local water balance. *Journal of Arid Environments*, 123:93-102.

Makurira, H., Savenije, H.H.G., Uhlenbrook, S., Rockström, J. & Senzanje, A. (2011). The effect of system innovations on water productivity in subsistence rainfed agricultural systems in semi-arid Tanzania. *Agricultural Water Management*, 98(11):1696-1703.

Mancosu, N., Snyder, R.L., Kyriakakis, G. & Spano, D. (2015). Water scarcity and future challenges for food production. *Water*, *7*(3):975-992.

March, H., Domènech, L. and Saurí, D. (2013). Water conservation campaigns and citizen perceptions: the drought of 2007–2008 in the Metropolitan Area of Barcelona. *Natural hazards*, 65(3):1951-1966.

Marlow, D.R., Moglia, M., Cook, S. & Beale, D.J. (2013). Towards sustainable urban water management: A critical reassessment. W*ater research*, 47(20):7150-7161.

Massarutto, A. & Ermano, P. (2013). Drowned in an inch of water: How poor regulation has weakened the Italian water reform. *Utilities Policy,* 24:20-31.

Matji, M.P. & Ruiters, C. (2015*). Funding and financing mechanisms for infrastructure delivery: multi-sector analysis of benchmarking of South Africa against*

developed countries. Conference proceedings of the AMPEAK Asset Management Conference held in Sydney on the 24-25 May 2015. (24-27).

Mattioli, M.C., Pickering, A.J., Gilsdorf, R.J., Davis, J. & Boehm, A.B. (2012). Hands and water as vectors of diarrheal pathogens in Bagamoyo, Tanzania. *Environmental science & technology*, 47(1):355-363.

Maxwell, D. M. (2013). Water Governance in Bolivia: Policy Options for Pro-Poor Infrastructure Reform. *CMC Senior Theses Paper*, *767*.

McCulloch, J.H. (1985). Miscellanea on Heteros* edasticity. *Econometrica (pre-1986)*, 53(2):483.

McDonald, R.I., Weber, K., Padowski, J., Flörke, M., Schneider, C., Green, P.A., Gleeson, T., Eckman, S., Lehner, B., Balk, D. & Boucher, T. (2014). Water on an urban planet: Urbanization and the reach of urban water infrastructure. *Global Environmental Change,* 27:96-105.

Meehan, K. (2013). Disciplining de facto development: water theft and hydrosocial order in Tijuana. *Environment and Planning D: Society and Space*, 31(2):319-336.

Mehta, L. (2014). Water and human development. *World development*, 59:59-69.

Mehta, M. and Knapp, A. (2004). Challenge of financing sanitation for Meeting the Millennium Development Goals. In *Challenge of financing sanitation for Meeting the Millennium Development Goals*. WSP. Available from: http://bases.bireme.br/cgi-bin/wxislind.exe/iah/online/?IsisScript=iah/iah.xis&src=google&base=REPIDISCA&lang=p&nextAction=lnk&exprSearch=24075&indexSearch=ID. (Accessed: 20 March 2016).

Meier, B.M., Kayser, G.L., Amjad, U.Q. & Bartram, J. (2013). Implementing an evolving human right through water and sanitation policy. *Water Policy*, *15*(1):116-133.

Mema, V. (2010). Impact of poorly maintained wastewater and sewage treatment plants: Lessons from South Africa. *ReSource*, 12:60-65.

Mendoza, E.C. (2013). Fiscal federalism in Mexico: distortions and structural traps. *Urban Public Economics Review*, (18):12.

Meng, Q., Chen, X., Lobell, D.B., Cui, Z., Zhang, Y., Yang, H. & Zhang, F. (2016). Growing sensitivity of maize to water scarcity under climate change. *Scientific reports*, *6*.

Mertens, D.M. (2014). *Research and Evaluation in Education and Psychology: Integrating Diversity With Quantitative, Qualitative, and Mixed Methods: Integrating Diversity With Quantitative, Qualitative, and Mixed Methods*. California, United States of America: Sage Publications.

Milford, L., Saha, D., Muro, M., Sanders, R. & Rittner, T. (2014). Clean Energy Finance Through the Bond Market. *Brookings Institution, Brookings Rockefeller Project on State and Metropolitan Innovation*. Available from: https://www.cdfa.net/cdfa/cdfaweb.nsf/ord/brookings-cdfa-ceg-041614.html/$file/CleanEnergyFunds.pdf. (Accessed: 24 May 2016).

Mills, D.E. (2014). The stewardship performance of forms of privatised water infrastructure. Doctoral dissertation, Australia, Brisbane: Queensland University of Technology.

Mirugi-Mukundi, G. (2014). South African Human Rights Commission, 2014-report on the Rights of Access to Sufficient Water and Sanitation: new publication. *ESR Review: Economic and Social Rights in South Africa*, 15(1), p.12.

Misi, J. (2013). Donor funding and sustainable rural development and its challenges in Zimbabwe*;* a case study of Mudzi district: 2000-2012*.* Doctoral dissertation. Zimbabwe: Bindura University of Science Education.

Mitnick, B. M. (2015). Agency Theory. (2:1–6).Wiley Encyclopedia of Management.

Miya, L. and Grobbelaar, S. (2015). *Risk-Based Maintenance of Physical Assets Of Water Infrastructure: A Case Study Of A Municipality*. Conference proceeding of the International Association for Management of Technology (IAMOT). Held in Cape Town, South Africa. Hosted by the Graduate School of Technology Management University of Pretoria South Africa. Available from: http://iamot2015.com/2015proceedings/documents/P117.pdf. (Accessed on 12 October 2016).

Miyamoto, K. and Biousse, K. (2014). Official Support for Private Sector Participation in Developing Country Infrastructure. OECD. Available from: http://www.oecd-ilibrary.org/development/official-support-for-private-sector-participation-in-developing-country-infrastructure_5jz14cd40nf0-en. (Accessed: 12 August 2016).

Molden, D.J., Vaidya, R.A., Shrestha, A.B., Rasul, G. & Shrestha, M.S. (2014). Water infrastructure for the Hindu Kush Himalayas. *International Journal of Water Resources Development*, 30(1):60-77.

Montgomery, D.C., Peck, E.A. & Vining, G.G. (2015). *Introduction to linear regression analysis*. Canada: John Wiley & Sons.

Montgomery, M.A. & Elimelech, M. (2007). Water and sanitation in developing countries: including health in the equation. *Environmental Science & Technology*, 41(1):17-24.

Moreno-Sanchez, R., Maldonado, J.H., Wunder, S. & Borda-Almanza, C. (2012). Heterogeneous users and willingness to pay in an ongoing payment for watershed protection initiative in the Colombian Andes. *Ecological Economics*, 75:126-134.

Morgan, B. (2006). Turning off the tap: urban water service delivery and the social construction of global administrative law. *European Journal of International Law*, 17(1):215-246.

Moriarty, P., Smits, S., Butterworth, J. & Franceys, R. (2013). Trends in rural water supply: Towards a service delivery approach. *Water Alternatives*, 6(3):329.

Morse, J.M. (2010). Sampling in grounded theory. *The SAGE handbook of grounded theory*, 229-244.

Mostert, J.W. & Van Heerden, J.H. (2015). A computable general equilibrium (CGE) analysis of the expenditure on infrastructure in the Limpopo economy in South Africa. *International Advances in Economic Research*, 21(2):227-236.

Mouton, J. (1996). *Understanding social research*. Van Schaik Publishers. ISBN 0-627-02163-8.

Moyo, M., Mvumi, B.M., Kunzekweguta, M., Mazvimavi, K., Craufurd, P. & Dorward, P. (2012). Farmer perceptions on climate change and variability in semi-arid Zimbabwe in relation to climatology evidence. *African Crop Science Journal*, 20(2):317-335.

Mueen Alam, K.H.A.N., Iqbal, M., Akram, M., Ahmad, M., Hassan, M.W. & Jamil, M. (2013). Recent advances in molecular tool development for drought tolerance breeding in cereal crops: a review. *Zemdirbyste-Agriculture,* 100(3): 325−334,

Mueller, N.D., Gerber, J.S., Johnston, M., Ray, D.K., Ramankutty, N. & Foley, J.A. (2012). Closing yield gaps through nutrient and water management. *Nature*, 490(7419):254-257.

Muller, M. & J. Lane. (2002). The National Water and Sanitation Programme in South Africa: turning the “right to water” into reality, Water and Sanitation Program. World Bank. 1(1). Available from: http://documents.worldbank.org/curated/en/770671468777256950/pdf/266260PAPER0English0Blue0Gold0no-08.pdf. (Accessed: 23 March 2016).

Naddeo, V., Scannapieco, D. & Belgiorno, V. (2013). Enhanced drinking water supply through harvested rainwater treatment. *Journal of Hydrology*, 498:287-291.

Nagaraj, N., Basavaraj, G., Rao, P.P., Bantilan, C. & Haldar, S. (2013). Sorghum and Pearl Millet Economy of India*. Economic & Political Weekly,* 48(52):75.

Naiga, R., Penker, M. & Hogl, K. (2015). Challenging pathways to safe water access in rural Uganda: From supply to demand-driven water governance. *International Journal of the Commons*, *9*(1).

National Institute for Communicable Diseases (2014). Outbreak of Diarrhoeal Disease in Bloemhof Municipality, North West Province, 2 June 2014. Available from: http://www.nicd.ac.za/?page=alerts&id=5&rid=343. (Accessed 30 June 2016)

Netswera, F.G. (2014). The underlying factors behind violent municipal service delivery protests in South Africa. *Journal of Public Administration,* 49(1): 261-273.

Ngoran, S.D., Dogah, K.E. & Xue, X. (2015). Assessing the impacts of Climate Change on Water Resources: The sub-Saharan Africa Perspective. *Journal of Economics and Sustainable Development*, 6(1):2015.

Nleya, N., Thompson, L., Tapscott, C., Piper, L. & Esau, M. (2011). Reconsidering the origins of protest in South Africa: some lessons from Cape Town and Pietermaritzburg. *Africanus*, 41(1):14-29.

Nuzzo, R. (2014). Scientific method: Statistical errors. *Nature,* 506 (7487):150–152. Available from: http://www.nature.com/news/scientific-method-statistical-errors-1.14700. (Accessed 18 December 2016).

O'Sullivan, N. & O'Dwyer, B. (2015). The structuration of issue-based fields: Social accountability, social movements and the Equator Principles issue-based field. *Accounting, Organisations and Society*, 43:33-55.

Obay, L., 2014. Financial innovation in the banking industry: the case of asset securitization. New York: Routledge.

Odhiambo, O. & Odada, J.E. (2010). *Addressing the Plight of Poor Households by Zero-rating Value Added Tax on Basic Commodities in Namibia (72).* Working Paper, International Policy Centre for Inclusive Growth. Econstor. Available from: https://www.econstor.eu/handle/10419/71792. (Accessed: 23 May 2016).

Ojuri, O.B. (2013). Investment methodology in planning and development of infrastructure: an unbalanced growth approach. *Journal of Construction Project Management and Innovation*, *3*(1):560-572.

Olsson, L. & Head, B. W. (2015). Urban water governance in times of multiple stressors: an editorial. *Ecology and Society*, 20(1):27. Available from: https://www.ecologyandsociety.org/vol20/iss1/art27/. (Accessed: 25 February 2015).

Onukwuli, A.G. (2014). Corporate Governance Practices and Regulatory Agencies on the Performance of Government Establishments in Sub-Saharan African. *Corporate Governance*, *6*(17).

Organisation for Economic Cooperation and Development (1997). Glossary of Environment Statistics, Studies in Methods, Series F, No. 67, United Nations,

New York, 1997. Available from: https://stats.oecd.org/glossary/detail.asp?ID=2903. (Accessed: 22 March 2016).

Ouyahia, M.A. (2006). *Public-private Partnerships for Funding Municipal Drinking Water Infrastructure: What are the Challenges: Discussion Paper*. Policy Research Initiative. Available from: http://publications.gc.ca/collections/Collection/PH4-35-2006E.pdf. (Accessed 17 July 2016).

Pacey, A. & Cullis, A. (1986). *Rainwater harvesting: the collection of rainfall and runoff in rural areas*. London: Intermediate technology publications.

Page, J. (2012). Can Africa Industrialise? *Journal of African Economies*, *21*(2):86-124.

Pahl-Wostl, C., Arthington, A., Bogardi, J., Bunn, S.E., Hoff, H., Lebel, L., Nikitina, E., Palmer, M., Poff, L.N., Richards, K. & Schlüter, M. (2013a). Environmental flows and water governance: managing sustainable water uses. *Current Opinion in Environmental Sustainability*, 5(3):341-351.

Pahl-Wostl, C., Arthington, A., Bogardi, J., Bunn, S.E., Hoff, H., Lebel, L., Nikitina, E., Palmer, M., Poff, L.N., Richards, K. & Schlüter, M. (2013b). Environmental flows and water governance: managing sustainable water uses. *Current Opinion in Environmental Sustainability,* 5(3):341-351.

Pahl-Wostl, C., Conca, K., Kramer, A. Maestu, J. & Schmidt, F. (2013). Missing links in global water governance: a processes-oriented analysis*. Ecology and Society* 18(2): 33.

Pahl-Wostl, C., Lebel, L., Knieper, C. and Nikitina, E. (2012). From applying panaceas to mastering complexity: toward adaptive water governance in river basins. *Environmental Science & Policy,* 23:24-34.

Palaniappan, M., Gleick, P.H., Allen, L., Cohen, M.J., Christian-Smith, J. & Smith, C. (2012). Water quality. Chapter 3 in *The World's Water* (pp. 45-72). Washington DC: Island Press/Center for Resource Economics.

Pandey, D.N., Gupta, A.K. & Anderson, D.M. (2003). Rainwater harvesting as an adaptation to climate change. *Current science*, 85(1):46-59.

Papoulis, A. & Pillai, S.U. (2002). *Probability, random variables, and stochastic processes*. New Dehli: Tata McGraw-Hill Education.

Patil, J.V. (Editor). (2016). *Millets and Sorghum: Biology and Genetic Improvement.* United Kingdom: John Wiley & Sons.

Peloso, M.M. (2014). *Navigating water access and governance in peri-urban Ashaiman, Ghana: a case study*. Doctoral dissertation. Canada: University of British Columbia.

Peredo, A.M. & Chrisman, J.J. (2006). Toward a theory of community-based enterprise. *Academy of Management Review*, 31(2):309-328.

Phetoane, B.M. (2012). *The effect of socio-demographic, socio-economic and environmental factors on under-five mortality in South Africa: analysis of the 1998 South African Demographic Health Survey dataset.* Doctoral dissertation. Johannesburg: University of the Witwatersrand.

Pickering, A.J. & Davis, J. (2012). Freshwater availability and water fetching distance affect child health in sub-Saharan Africa. *Environmental Science & Technology*, 46(4):2391-2397.

Pillay, L. & Olaniran, A.O. (2016). Assessment of physicochemical parameters and prevalence of virulent and multiple-antibiotic-resistant Escherichia coli in treated effluent of two wastewater treatment plants and receiving aquatic milieu in Durban, South Africa. *Environmental monitoring and assessment*, 188(5):1-20.

Pilon, D. (2013). *Wrestling with democracy: Voting systems as politics in the twentieth-century West* (39). Toronto: University of Toronto Press.

Pina, V., Ivanov, M. and Torres, L., (2016). Financial Transparency of Local Governments in Eastern EU Countries. *Revue Internationale des Gouvernements Ouverts*, 2, pp.191-202.

Population Reference Bureau (2016). Human Population: Population Growth. Available from: http://www.prb.org/Publications/Lesson-Plans/HumanPopulation/PopulationGrowth.aspx. (Accessed 25 October 2016).

Porter, J.R., Xie, L., Challinor, A.J., Cochrane, K., Howden, S.M., Iqbal, M.M., Lobell, D.B. & Travasso, M.I. (2014). Chapter 7 in *Food security and food production systems*. England: Cambridge.

Prabhu, S.S. & Mohapatra, N. (2013). Water Resource Management in India: The Institutional Challenges. *Water Governance,* 1:40.

Prasad, N. (2006). Privatisation results: Private sector participation in water services, *Development Policy Review*, 24 (6):669-692.

Proost, S., Dunkerley, F., De Borger, B., Gühneman, A., Koskenoja, P., Mackie, P., & Van der Loo, S. (2011). When are subsidies to trans-European network projects justified? *Transportation Research Part A: policy and practice,* 45(3):161-170.

Qadir, M., Wichelns, D., Raschid-Sally, L., McCornick, P.G., Drechsel, P., Bahri, A. & Minhas, P.S. (2010). The challenges of wastewater irrigation in developing countries. *Agricultural Water Management,* 97(4):561-568.

Quinn, C., Ziervogel, G., Taylor, A., Takama, T. & Thomalla, F. (2011). Coping with multiple stresses in rural South Africa. *Ecology and Society*, *16*(3).

Qureshi, M.E., Hanjra, M.A. & Ward, J. (2013). Impact of water scarcity in Australia on global food security in an era of climate change. *Food Policy*, 38:136-145.

Qureshi, N. & Shah, J. (2014). Aging infrastructure and decreasing demand: A dilemma for water utilities. *J. Am. Water Works Assoc,* 106(1):51-61.

Raelin, J.D. & Bondy, K. (2013). Putting the Good Back in Good Corporate Governance: The Presence and Problems of Double-Layered Agency Theory. *Corporate Governance: An International Review*, 21(5):420-435.

Rajkumar, A.S. and Swaroop, V. (2008). Public spending and outcomes: Does governance matter? *Journal of development economics*, 86(1):96-111.

Ranchod, N., Sheridan, C.M., Pint, N., Slatter, K. & Harding, K.G. (2015). Assessing the blue-water footprint of an opencast platinum mine in South Africa. *Water SA*, *41*(2):287-293.

Rand Water (2017). Water Situation in South Africa. Available from: http://www.waterwise.co.za/site/water/environment/situation.html. (Accessed: 2 May 2017).

Reale, E. (2014). Challenges in higher education research: the use of quantitative tools in comparative analyses. *Higher Education*, 67(4):409-422.

Reddy, P. & Wallis, M. (2012). Local economic development: A critique of the African experience. *Politeia*, 31(2):70-88.

Reddy, V.R. & Kurian, M. (2015). Life-Cycle Cost Analysis of Infrastructure Projects. Chapter 6 in *Governing the Nexus* (105-127). Switzerland: Springer International Publishing.

Reid, A.E., Hendricks, M.K., Groenewald, P. & Bradshaw, D. (2016). Where do children die and what are the causes? Under-5 deaths in the Metro West geographical service area of the Western Cape, South Africa, 2011. *SAMJ: South African Medical Journal*, *106*(4):359-364.

Republic of South Africa. 1998. National Water Act (Act No. 36 of 1998).*Government Gazette*, (19182). Available from: http://cer.org.za/wp-content/uploads/2010/05/36-OF-1998-NATIONAL-WATER-ACT_2-Sep-2014-to-date.pdf. (Accessed 2 May 2016).

Rice, W.R. (1989). Analyzing tables of statistical tests. *Evolution*, 43(1):223-225.

Richards, A.A. (2016). *Physical, Regulatory and Reputational Water Risks as Predictors of Water Stewardship among Global Corporations.* Doctoral dissertation. Virginia: George Mason University.

Ringler, C. & Zhu, T. (2015). Water resources and food security. *Agronomy Journal*, *107*(4):1533-1538.

Rogers, P. & Hall, A.W. (2003). *Effective water governance* (Vol. 7). Global water partnership. Available from: https://dlc.dlib.indiana.edu/dlc/handle/10535/4995. (Accessed: 22 May 2015).

Rogers, P. P., Jalal, P. P. R. K. F., Boyd, J. A., & Jalal, K. F. (2012). *An introduction to sustainable development*. UK: Earthscan.

Romano, G., Guerrini, A. & Vernizzi, S. (2013). Ownership, investment policies and funding choices of Italian water utilities: an empirical analysis. *Water resources management,* 27(9):3409-3419.

Rose-Ackerman, S. & Palifka, B.J. (2016). *Corruption and government: Causes, consequences, and reform*. New York: Cambridge university press.

Rose-Ackerman, S. (2005). Challenge of Poor Governance and Corruption, The. *Especial 1 DIREITO GV L. Rev.*, 207.

Rosegrant, M.W. (1997). *Water resources in the twenty-first century: Challenges and implications for action* (Vol. 20). Intl Food Policy Res Inst. Available from: https://books.google.co.za/books?hl=en&lr=&id=psAXrUs7vLUC&oi=fnd&pg=PP3&dq=Rosegrant,+M.W.+(1997).+Water+resources+in+the+twenty-first+century:+Challenges+and+implications+for+action+(Vol.+20).+Intl+Food+Policy+Res+Inst.&ots=6nAFflWQnq&sig=XgMk0j7vNR89zsruJBVRr2y8jfs#v=onepage&q&f=false. (Accessed: 24 July 2016).

Rosen, S., Vincent, J.R., MacLeod, W., Fox, M., Thea, D.M. & Simon, J.L. (2004). The cost of HIV/AIDS to businesses in southern Africa. *Aids*, 18(2):317-324.

Rossi, P.E. (2014). Invited Paper—Even the Rich Can Make Themselves Poor: A Critical Examination of IV Methods in Marketing Applications. *Marketing Science*, 33(5):655-672.

Rost, K.T., Ratfelder, G. & Topbaev, O. (2015). Problems of rural drinking water supply management in Central Kyrgyzstan: a case study from Kara-Suu village, Naryn Oblast. *Environmental Earth Sciences,* 73(2):863-872.

Roudier, P., Sultan, B., Quirion, P. & Berg, A. (2011). The impact of future climate change on West African crop yields: What does the recent literature say? *Global Environmental Change*, 21(3):1073-1083.

Rouse, M. (2014). The worldwide urban water and wastewater infrastructure challenge. *International Journal of Water Resources Development,* 30(1):20-27.

Rugemalila, R. & Gibbs, L. (2015). Urban water governance failure and local strategies for overcoming water shortages in Dar es Salaam, Tanzania. *Environment and Planning C: Government and Policy*, 33(2):412-427.

Ruiters, C. (2013). Funding models for financing water infrastructure in South Africa: Framework and critical analysis of alternatives. *Water SA*, 39(2):313-326.

Sachs, J.D. (2012). From millennium development goals to sustainable development goals. *The Lancet*, 379(9832):2206-2211.

Sage, C. (2014). The transition movement and food sovereignty: From local resilience to global engagement in food system transformation. *Journal of Consumer Culture*, 14(2):254-275.

Sahasranaman, A. (2012). Panchayat Finances and the Need for Devolutions from the State Government. *Economic and Political Weekly*, 47(4).

Sahin, O., Siems, R.S., Stewart, R.A. & Porter, M.G. (2016). Paradigm shift to enhanced water supply planning through augmented grids, scarcity pricing and adaptive factory water: a system dynamics approach. *Environmental Modelling & Software,* 75:348-361.

Sahin, O., Stewart, R.A. & Porter, M.G. (2015). Water security through scarcity pricing and reverse osmosis: a system dynamics approach. *Journal of Cleaner Production,* 88:160-171.

Sambu, D.K. & Tarhule, A. (2013). Progress of water service providers in meeting millennium development goals in Kenya. *African Geographical Review*, 32(2):105-124.

Sanchez, P.A., Denning, G.L. & Nziguheba, G. (2009). The African green revolution moves forward. *Food Security,* 1(1):37-44.

Sanders, K.T., King, C.W., Stillwell, A.S. & Webber, M.E. (2013). Clean energy and water: assessment of Mexico for improved water services and renewable energy. *Environment, development and sustainability*, 15(5):1303-1321.

Sapkota, J.B. (2014). Access to Infrastructure and Human Development: Cross-Country Evidence. *Perspectives on the Post-2015 Development Agenda*, 59.

Scarborough, H., Sahin, O., Porter, M. & Stewart, R. (2015). Long-term water supply planning in an Australian coastal city: Dams or desalination? *Desalination,* 358:61-68.

Scheaffer, R., Mendenhall III, W., Ott, R. & Gerow, K. (2011). *Elementary survey sampling*. Boston: Brooks/Cole Cengage Learning.

Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N.W., Clark, D.B., Dankers, R., Eisner, S., Fekete, B.M., Colón-González, F.J. & Gosling, S.N. (2014). Multimodel assessment of water scarcity under climate change. *Proceedings of the National Academy of Sciences,* 111(9):3245-3250.

Schillemans, T. & Busuioc, M. (2015). Predicting public sector accountability: From agency drift to forum drift. *Journal of Public Administration Research and Theory*, 25(1):191-215.

Schillemans, T. (2013). Moving Beyond The Clash of Interests: On stewardship theory and the relationships between central government departments and public agencies. *Public Management Review*, 15(4):541-562.

Schneider, M., Teske, P. & Mintrom, M. (2011). *Public entrepreneurs: Agents for change in American government*. New Jersey: Princeton University Press.

Schrag, F. (1992). In defence of positivist research paradigms. *Educational Researcher*, 21(5):5-8.

Schuetze, T. & Santiago-Fandiño, V. (2013). Quantitative assessment of water use efficiency in urban and Domestic Buildings. *Water*, *5*(3):1172-1193.

Scott, A.J. (2012). Illusions in Regression Analysis. *International Journal of Forecasting*. 28 (3): 689.

Selvakumar, A. & Tafuri, A.N. (2012). Rehabilitation of aging water infrastructure systems: Key challenges and issues. *Journal of Infrastructure Systems,* 18(3): 202-209.

Sen, A. (2004), Elements of a theory of human rights. *Philosophy & Public Affairs*, 32 (4): 315-56.

Setlhogile, T., Arntzen, J. & Pule, O.B. (2016). Economic accounting of water: The Botswana experience. *Physics and Chemistry of the Earth, Parts A/B/C*. Available from: http://www.sciencedirect.com/science/article/pii/S1474706516301152. (Accessed: 21 June 2016).

Shafir, E. (Editor). (2013). *The behavioral foundations of public policy*. New Jersey: Princeton University Press.

Shah, T. (2014). Groundwater governance and irrigated agriculture. *TEC Background Papers*, (19):69.

Shapiro, I. (2013). Transportable disaster-relief systems. *U.S. Patent,* 8(404):113.

Shiferaw, B., Kassie, M., Jaleta, M. & Yirga, C. (2014). Adoption of improved wheat varieties and impacts on household food security in Ethiopia. *Food Policy*, 44:272-284.

Shiraz Rahaman, A., Everett, J. and Neu, D. (2007). Accounting and the move to privatize water services in Africa. *Accounting, Auditing & Accountability Journal*, *20*(5):637-670.

Siebert, S., Burke, J., Faures, J.M., Frenken, K., Hoogeveen, J., Döll, P. and Portmann, F.T. (2010). Groundwater use for irrigation–a global inventory. *Hydrology and Earth System Sciences,* 14(10):1863-1880.

Simon, M. (2011). Assumptions, limitations and delimitations. *Seattle, Washington*. Available from: http://www.dissertationrecipes.com/. (Accessed: 7 July 2015).

Sinyolo, S., Mudhara, M. & Wale, E. (2014). The impact of smallholder irrigation on household welfare: The case of Tugela Ferry irrigation scheme in KwaZulu-Natal, South Africa. *Water SA*, 40(1):145-156.

Skeel, D.A. (2013). Is Bankruptcy the Answer for Troubled Cities and States? *Houston Law Review*, 13-9.

Smith, P. & Gregory, P.J. (2013). Climate change and sustainable food production. *Proceedings of the Nutrition Society*, 72(01):21-28.

Snieska, V. & Simkunaite, I. (2015). Socio-Economic Impact of Infrastructure Investments. *Engineering Economics*, 63(4).

Song, Y., Dong, P., Wang, X. and Lin, L., 2017. Rapid penalized likelihood-based outlier detection via heteroskedasticity test. Journal of Statistical Computation and Simulation, 87(6):1206-1229.

Sorg, A., Bolch, T., Stoffel, M., Solomina, O. & Beniston, M. (2012). Climate change impacts on glaciers and runoff in Tien Shan (Central Asia). *Nature Climate Change*, 2(10):725-731.

South African Value-Added Tax Act No. 89 of 1991 (the VAT Act). Vailable from: Value-Added Tax Act, No 89 of 1991 - Acts Online. https://www.acts.co.za/value-added-tax-act-1991. Accessed: 12 October 2016).

Spaling, H., Brouwer, G. & Njoka, J. (2014). Factors affecting the sustainability of a community water supply project in Kenya. *Development in Practice,* 24(7):797-811.

Srinivasan, V., Seto, K.C., Emerson, R. & Gorelick, S.M. (2013). The impact of urbanization on water vulnerability: a coupled human–environment system approach for Chennai, India. *Global Environmental Change,* 23(1):229-239.

Stapenhurst, R. and O'Brien, M., (2007). Accountability in governance. The World Bank, Washington DC. Available from http://sitesources.worldbank.org/PUBLICSECTOR AND GOVERNANCE/Resources/Accountability/Governance.pdf (Accessed: 12 March, 2009).

Statistics South (2011) Poverty trends in South Africa, available at:

Statistics South Africa (2010) GHS Series Volume III, Water and sanitation 2002–2010, Water and sanitation 2002–2010, available at:

Statistics South Africa (2011). Poverty trends in South Africa: An examination of absolute poverty between 2006 and 2011. Available from: http://www.statssa.gov.za/?page_id=1854&PPN=Report-03-10-06/Report-03-10-06March2014.pdf. (Accessed: 12 March 2017).

Statistics South Africa (2017). GHS Series Volume III Water and sanitation 2002–2010 In-depth analysis of the General Household Survey data. Available from: http://www.statssa.gov.za/publications/Report-03-18-02/Report-03-18-022010.pdf. (Accessed: 12 March 2017).

Sultan, B., Roudier, P., Quirion, P., Alhassane, A., Muller, B., Dingkuhn, M., Ciais, P., Guimberteau, M., Traore, S. & Baron, C. (2013). Assessing climate change impacts on sorghum and millet yields in the Sudanian and Sahelian savannas of West Africa. *Environmental Research Letters*, 8(1):014040.

Tambudzai, R., Everisto, M. & Gideon, Z. (2013). Decentralising Zimbabwe's water management: The case of Guyu-Chelesa irrigation scheme. *Physics and Chemistry of the Earth, Parts A/B/C*, 66:139-147.

Tamea, S., Carr, J.A., Laio, F. & Ridolfi, L. (2014). Drivers of the virtual water trade. *Water Resources Research*, 50(1):17-28.

Taplin, R., Rusmin, R. & Brown, A. (2013). Financial discrepancies in political party funding by Indonesian local government authorities. *International Journal of Public Administration*, *36*(1):16-25.

Taylor, D.L., Kahawita, T.M., Cairncross, S. & Ensink, J.H. (2015). The impact of water, sanitation and hygiene interventions to control cholera: A systematic review. *PloS one*, 10(8):0135676.

Taylor, R.G., Scanlon, B., Döll, P., Rodell, M., Van Beek, R., Wada, Y., Longuevergne, L., Leblanc, M., Famiglietti, J.S., Edmunds, M. & Konikow, L. (2013). Ground water and climate change. *Nature Climate Change,* 3(4):322-329.

Tello, E., Hazelton, J. & Cummings, L. (2016). Potential users' perceptions of general purpose water accounting reports. *Accounting, Auditing & Accountability Journal*, *29*(1).

Temin, P. & Vines, D. (2013). *The leaderless economy: Why the world economic system fell apart and how to fix it.* New Jersey: Princeton University Press.

Teutschbein, C. & Seibert, J. (2012). Bias correction of regional climate model simulations for hydrological climate-change impact studies: Review and evaluation of different methods. *Journal of Hydrology,* 456:12-29.

Tortajada, C. & Joshi, Y.K. (2013). Water demand management in Singapore: involving the public. *Water resources management*, *27*(8):2729-2746.

Tortajada, C. (2014a). Water infrastructure as an essential element for human development. *International Journal of Water Resources Development*, *30*(1), pp.8-19.

Tortajada, C. (2014b). Any Progress Towards Sustainable Development or at Least Sustained Development? Chapter 33 in *Governing Asia: Reflections on a Research Journey*. Singapore: World Scientific Publishing.

Trans-Caledon Tunneling Authority (2016). Annual reports. Available from: http://www.tcta.co.za/annual-report. (Accessed: 12 March 2016).

Turpie, J. & Visser, M. (2013). The impact of climate change on South Africa's rural areas. Chapter 4 in *Financial and Fiscal Commission*, *Submission for the Division of Revenue, 2013/14.* Midrand: Financial and Fiscal Commission.

Ubuoh, A., Ege, C.A., Ogbuji, S., & Onifade, S. (2012). Potentials of domestic rainwater harvesting in Kwa Ibom State, Nigeria using supply side approach. *J. of Environmental Science and Resource Management,* 4:1-9.

Uitto, J.I. & Shaw, R. (2016). *Sustainable Development and Disaster Risk Reduction: Introduction.* In Sustainable Development and Disaster Risk Reduction. Japan: Springer.

United Nations Development Programme (2006). Human Development Report 2006: Beyond scarcity: Power, Poverty and the global water crisis. Available at http://undp.org/en/reports/global/hdr2006/. (Accessed February 2015).

United Nations International Children's Emergency Fund (2012). *Progress on Drinking Water and Sanitation–2012 Update.* Available from: https://www.unicef.org/media/files/JMPreport2012.pdf. (Accessed: 9 November 2016).

Urich, C., Bach, P.M., Sitzenfrei, R., Kleidorfer, M., McCarthy, D.T., Deletic, A. & Rauch, W. (2013). Modelling cities and water infrastructure dynamics. *Engineering Sustainability*, 166(5):301-308.

Van Houweling, E., Hall, R., Diop, A.S., Davis, J. & Seiss, M. (2012). The role of productive water use in women's livelihoods. Evidence from rural Senegal. *Water Alternatives*, 5(3):658.

Van Puyvelde, S., Caers, R., Du Bois, C. & Jegers, M. (2012). The governance of nonprofit organisations: Integrating agency theory with stakeholder and stewardship theories. *Nonprofit and Voluntary Sector Quarterly*, 41(3):431-451.

Van Slyke, D.M. (2007). Agents or stewards: Using theory to understand the government-nonprofit social service contracting relationship. *Journal of Public Administration Research and Theory*, 17(2):157-187.

Vinnari, E. & Näsi, S. (2013). Financial and technical competence of municipal board members: empirical evidence from the water sector. *Critical Perspectives on Accounting*, 24(7):488-501.

Vogt, W.P. & Johnson, R.B. (2011). *Dictionary of Statistics & Methodology: A Nontechnical Guide for the Social Sciences: A Nontechnical Guide for the Social Sciences*. California: Sage.

Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P. & Davies, P. M. (2010). Global threats to human water security and river biodiversity. *Nature*, 467(7315):555-561.

Vu, L. & Glewwe, P. (2011). Impacts of rising food prices on poverty and welfare in Vietnam. *Journal of Agricultural and Resource Economics*, 14-27.

Vyas-Doorgapersad, S. (2010). Capacity building for developmental local government in South Africa. *Journal of Public Administration,* 45(1):43-57.

Wada, Y., Wisser, D. & Bierkens, M.F.P. (2014). Global modeling of withdrawal, allocation and consumptive use of surface water and groundwater resources. Earth System Dynamics, 5(1):15.

Wagenvoort, R., De Nicola, C. and Kappeler, A. (2011). Infrastructure Finance in Europe: Composition, Evolution and Crisis Impact. *EIB Papers,* 15(1):2010.

Waldman, D.M. (1983). A note on algebraic equivalence of White's test and a variation of the Godfrey/Breusch-Pagan test for heteroscedasticity. *Economics Letters*, 13(2-3):197-200.

Walker, C.L.F., Rudan, I., Liu, L., Nair, H., Theodoratou, E., Bhutta, Z.A., O'Brien, K.L., Campbell, H. & Black, R.E. (2013). Global burden of childhood pneumonia and diarrhoea. *The Lancet*, *381*(9875):1405-1416.

Wall, K. (2011). *SAICE Infrastructure Report Card for South Africa*. The South African Institution of Civil Engineering (SAICE). Available from: http://researchspace.csir.co.za/dspace/handle/10204/5807. (Accessed: 11 May 2016).

Wang, Y.B., Wu, P.T., Zhao, X.N. and Engel, B.A. (2014). Virtual water flows of grain within China and its impact on water resource and grain security in 2010. *Ecological Engineering,* 69:255-264.

Wasserstein, R. L. & Lazar, N. A. (2016). The ASA's Statement on p-Values: Context, Process, and Purpose". *The American Statistician*. 70(2):129–133.

Wehn, U. & Evers, J. (2014) *Citizen observatories of water: Social innovation via eParticipation.* Conference proceeding of the 2nd international conference on ICT for sustainability held in Stockholm on August 24-27, 2014. Organized by KTH Royal Institute of Technology in cooperation with VU University Amsterdam. Available from: http://aims.fao.org/activity/blog/2nd-international-conference-ict-sustainability-ict4s-2014. (Accessed: 25 May 2015).

Wellard, H., 2017. Sustainable development goals. *Incite,* 38(3/4):16.

Wesselink, A., Hoppe, R. and Lemmens, R. (2015). Not just a tool. Taking context into account in the development of a mobile app for rural water supply in Tanzania. *Water alternatives*, *8*(2).

Wetzel, W.T. (2013). *Reducing general fund expenditures stormwater in West Sacramento, California.* Doctoral dissertation. Sacramento: California State University.

Whale coast concervation, 2017. South Africa: Geography and Climate. Available from: http://whalecoastconservation.org.za/south-africa-geography-and-climate. (Accessed: 12 May 2017).

Wheeler, S., Zuo, A. & Bjornlund, H. (2013). Farmers' climate change beliefs and adaptation strategies for a water scarce future in Australia. *Global Environmental Change,* 23(2):537-547.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica: Journal of the Econometric Society,* 817-838.

Wibowo, A. & Mohamed, S. (2010). Risk criticality and allocation in privatised water supply projects in Indonesia. *International Journal of Project Management*, 28(5):504-513.

Wichelns, D. (2013). Enhancing the performance of water prices and tariff structures in achieving socially desirable outcomes. *International Journal of Water Resources Development*, *29*(3), 310-326.

Wild, S. (2015). Accounting for water: Institutional, cultural and ideological barriers to water reporting by major Australasian corporate and public benefit entities. Available from: https://ir.canterbury.ac.nz/handle/10092/11124. (Accessed: 13 May 2016).

Windsor, D., 2014. Corporate Governance as an Antidote to Corruption in Emerging Markets. In *Corporate Governance in Emerging Markets*. 423-444. Berlin, Heidelberg: Springer.

Winpenny, J. (2003). Report of the world panel on financing water infrastructure: Financing water for all. *Executive Summary. March*. Available from: http://www.yemenwater.org/?tag=strategy. (Accessed: 22 April 2016).

World Bank Group (Editor) (2012). *World Development Indicators 2012*. World Bank Publications. Available from: http://data.worldbank.org/indicator. (Accessed: 3 March 2015).

World Health Organisation (2004). *Guidelines for drinking-water quality: recommendations (Vol1), (3rd Edition)*. Geneva. World Health Organisation.

Wu, P. & Tan, M. (2012). Challenges for sustainable urbanization: a case study of water shortage and water environment changes in Shandong, China. *Procedia Environmental Sciences,* 13:919-927.

Wu, X., House, R.S. & Peri, R. (2016). Public-private partnerships (PPPs) in water and sanitation in India: lessons from China. *Water Policy*, 2016010.

Xinhua. (2012). Re: World meets Millennium safe water goals: 08 March. UN. Available from Chinadaily: http://europe.chinadaily.com.cn/world/2012-03/08/content_14791446.htm (Accessed: 23 April 2013).

Xu, J., Yu, Z., Zhong, W. & Xing, Z. (2016). Urban Water Metabolism Carrying Capacity Simulation Prediction And Governance Strategies Based On. *Journal of Residuals Science & Technology*, 13(7).

Yang, H., Bain, R., Bartram, J., Gundry, S., Pedley, S. & Wright, J. (2013). Water safety and inequality in access to drinking water between rich and poor households. *Environmental science & technology*, 47(3):1222-1230.

Yang, S.Q. & Liu, P.W. (2010). Strategy of water pollution prevention in Taihu Lake and its effects analysis. *Journal of Great Lakes Research*, 36(1):150-158.

Yaro, J.A. (2013). The perception of and adaptation to climate variability/change in Ghana by small-scale and commercial farmers. *Regional Environmental Change*, 13(6):1259-1272.

APPENDICES

Appendix 1

Water Infrastructure Financing, Water Provision and Governance Variables in South Africa 1994 – 2014

Year	WAFin	Gov Effect	Corr	Regu	Violence	ACC	Voice	WP
1994	4393258	0.88	0.76	0.34	-0.43	0.646	0.221	81
1995	4393258	0.88	0.76	0.34	-0.43	0.646	0.221	81
1996	4393258	0.88	0.76	0.34	-0.43	0.646	0.221	81
1997	4393258	0.88	0.76	0.34	-0.58	0.646	0.221	81
1998	7397637	0.88	0.65	0.27	-0.58	0.646	0.221	81
1999	9142106	0.6	0.65	0.27	-0.58	0.6612	0.2262	81
2000	9142106	0.6	0.61	0.4	-0.25	0.6612	0.2262	81
2001	9142106	0.69	0.61	0.4	-0.25	0.5472	0.1872	87
2002	9142106	0.6	0.39	0.63	-0.32	0.5472	0.1872	87
2003	9142106	0.64	0.34	0.78	-0.33	0.4788	0.1638	87
2004	14602000	0.68	0.48	0.67	-0.12	0.532	0.182	87
2005	16694000	0.66	0.58	0.67	-0.15	0.5548	0.1898	87
2006	18601000	0.64	0.43	0.71	0.05	0.4864	0.1664	91
2007	16746000	0.5	0.22	0.53	0.2	0.494	0.169	91
2008	19102000	0.49	0.61	0.5	0.04	0.4332	0.1482	92
2009	20953000	0.52	0.14	0.4	-0.11	0.418	0.143	93
2010	23965000	0.48	0.09	0.16	-0.02	0.418	0.143	93
2011	24626000	0.39	0.03	0.16	0.03	0.4408	0.1508	94
2012	23704000	0.41	-0.16	0.38	-0.02	0.4408	0.1508	95
2013	32220000	0.33	-0.12	0.41	-0.06	0.4256	0.1456	95
2014	33427000	0.43	-0.12	0.41	-0.06	0.4408	0.1508	95

Source: World Bank Group (2012) and Trans-Caledon Tunneling Authority (2016).

Appendix 2

Water Provision and Cereal Production in South Africa 1994 - 2014

Year	WP	CerealProd
1994	81	20000
1995	81	20729
1996	81	27206
1997	81	30654
1998	81	30000
1999	81	29542
2000	81	29579
2001	87	25000
2002	87	20000
2003	87	18116
2004	87	18435
2005	87	21738
2006	91	14478
2007	91	22000
2008	92	21853
2009	93	27325
2010	93	17800
2011	94	17900
2012	95	18500
2013	95	19000
2014	95	18510

Source: Department of Agriculture Forestry and Fisheries (1997); FAOUN (n.d) and World Bank Group (2012).

Appendix 3

Water Provision per Province and Poverty Incidence Per Province 2006 - 2011

Year	Province	Pov. Incidence	Water Provision by Province	Year	Province	Pov. Incidence	Water Provision by Province	Year	Province	Pov. Incidence	Water Provision by Province
2006	Western Cape	27	1 329	2009	Western Cape	25.2	1 473	2011	Western Cape	17.8	1 517
2006	Eastern Cape	55.8	1 154	2009	Eastern Cape	55	1 321	2011	Eastern Cape	47.5	1 324
2006	Northern Cape	47.5	278	2009	Northern Cape	49	306	2011	Northern Cape	36.5	312
2006	Free State	3 8.5	781	2009	Free State	48.2	845	2011	Free State	30.5	875
2006	KwaZulu-Natal	51.3	2 062	2009	KwaZulu-Natal	48.7	2 284	2011	KwaZulu-Natal	42	2 362
2006	North West	45.2	841	2009	North West	46.6	918	2011	North West	37.2	939
2006	Gauteng	22.6	3 099	2009	Gauteng	24	3 503	2011	Gauteng	16.2	3 618
2006	Mpumalanga	53.8	801	2009	Mpumalanga	53.1	904	2011	Mpumalanga	38.3	923
2006	Limpopo	59.8	1 143	2009	Limpopo	67.7	1 201	2011	Limpopo	50.9	1 286

Source: Statistics South Africa (2010) and Statistics South (2011)